# MODELS ASX-16, AR-12, AND DTS OPERATING MANUAL

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# SECTION I

# HARDWARE

## 1-1. Introduction

Some of the information in SECTION I of this manual is repeated in Section II. It is not necessary to read Section I to use the equipment.

Instructions for controlling Models ASX-16, AR-12 and DTS, using the IEEE-488 bus, are provided in Section II of this manual.

Figure 1-1A shows a simple block diagram of the Model ASX-16. Its major sections include a bank of Generator Modules (with attached filters), a Modulation Generator, and a programmable RF attenuator (1 dB to 81 dB).

Figure 1-1B shows a simple block diagram of the Model AR-12. Its major sections include a bank of RF filters, a programmable RF attenuator (10 dB to 70 dB), an RF-frequency processor, and an audio-frequency distortion analyzer.

Figure 1-1C shows a simple block diagram of the Model DTS. Its major sections include those from the Models ASX-16 and AR-12, plus additional RF relays and amplifiers. These coaxial relays, plus the ones contained in the "white box" (see below) allow the DTS to quickly switch between a wide variety of tests and measurements. The Model DTS also contains many application-specific items required in a fully-automatic distortion testing system. A typical Model DTS may contain one or more of the following remote-controllable equipment:

Custom-designed switch/test fixture (know as the "white box,"
which may include a Noise Source, RF Relays, RF amplifiers,
and a customer-supplied test fixture)
Power Meter (model varies with customer requirements)
Spectrum Analyzer "
Power Supply "
Digital Multimeter "
Frequency Synthesizer "
Frequency Counter "

The first of these items is manufactured by Matrix; the remaining equipment is supplied by other manufacturers (as appropriate to the customer's needs). Some applications will require less equipment; others may require more. The schematic of the "white box" is illustrated in Figure 1-2.

## 1-2. Theory of Operation

The theory of operation of the Model ASX-16 and Model AR-12 are covered separately. The Model DTS includes both of these devices. In the Model DTS, the ASX-16 portion controls the following (some items may be missing in your Model DTS):

Generator Modules
GA/GB Coaxial Relay
GFIN/GFOUT Coaxial Relay
1 dB and 10 dB RF Step Attenuators
RF amplifiers and "white box" Coaxial Relays
DC Power to the Noise Source
Polarity Reversing Relay for Unit Under Test's DC Power

The Receiver Controller controls the following portions of the DTS (the below-listed items, along with the Receiver Controller, make up the DTS's AR-12):

Receiver's 10 dB RF Attenuator
Receiver Filter Selector
Receiver Audio Attenuator and Detector
Composite Triple Beat Detector
Commutative Filter and Detector

### 1-2.1. The ASX-16's Generator Controller

Figure 1-1A shows a simple block diagram of the Model ASX-16. Its major sections include a bank of Generator Modules (with attached filters), a Modulation Generator, and a programmable RF attenuator (1 dB to 81 dB). The operation of these sections are determined by the Generator Controller.

The Generator Controller is illustrated in Figure 1-3. Based on a 6502 Central Processing Unit (CPU), the Generator Controller produces a sixteen-line Address Bus (A0 through A15), and an eight-line Data Bus (D0 through D7). The CPU generates a clock ($O_2$) and a Read/Write signal (R/W). These signals are used by other integrated circuits (ICs) in Figure 1-3.

The CPU can be reset by either of two methods. The CPU can be reset by the removal of power from the ASX-16 (in other words, turn the unit off). This causes the 1 microfarad capacitor on pins 5 and 6 of IC 10 to discharge. When the power is restored, this capacitor will slowly charge up. Until the charge approaches approximately 3 Volts, the 2N3904 transistor on pin 40 of the CPU will be saturated (conducting strongly), holding the RESET line low. When the capacitor is charged sufficiently, the transistor will stop conducting, and the RESET line will go to a high state. The CPU can also be reset by placing a short circuit from J1 P12 to ground. This is accomplished by pressing the ASX-16's front panel RESET button.

The remaining three gates of IC 10 make up the Generator Controller's CPU clock. One gate of IC 10 acts as an oscillator; the remaining two gates act as a buffer for the clock.

The external lines going to the CPU's READY, IRQ, and NMI pins are not used, although the IRQ input is connected to the IEEE-488 Controller (IC 5), allowing the Generator Controller to respond to the IEEE-488's "Bus Clear" and "Device Clear" system commands.

The Generator Controller contains 8K of ROM (read-only memory) and 2K of RAM (random access memory). Input/output to the remainder of the ASX-16 is through tri-level buffers and data latches. The Controller contains two banks of rotary switches which set both the ASX-16's IEEE-488 address and the ASX-16's customer-set Identification Number. The "IEEE-488 Address" switches are

nly read once, immediately after a reset or power-up. If the IEEE-488 address is changed while the ASX-16 is running, the unit will have to be reset (see above) so that the ASX-16 can read the new address. The "Identification Number" switches are read each time the "I" command is received by the ASX-16.

The outputs from J2 are broken into two fields: LS0 through LS3 and LS4 through LS7. The remaining pins of J2 are input lines. LS4 through LS7 are decoded down to fifteen Bank Select lines using a 4-to-16 line decoder. These select lines are used throughout the ASX-16 to enable data transfers to various parts of the Generator. LS0 through LS3 select between devices which share a common Bank Select line.

Connector J3 contains data lines labeled D0 through D7. Note that these are not the same D0 through D7 which represent the CPU's data bus--these are latched, buffered signals. The CPU's data bus (D0-D7) is used **exclusively** on the Generator Controller board, and does not have connections off the board. The remaining pins of J3 are input signals (usually not used in the ASX-16). D0 through D7 carry the general-purpose data to all circuits within the ASX-16.

The final portion of the Generator Controller is the IEEE-488 interface section. The TMS9914 is a special-purpose microprocessor which handles the actual communications with the IEEE-488 bus. It drives two other ICs which interface the Generator Controller with the rest of the IEEE-488 bus.

### 1-2.2. Operation of the Generator Controller

On power-up (or reset), the Generator Controller sets parts of the ASX-16 to known, protected states. When the unit is first turned on, the DC power supply to the Generator modules is turned off. This is to protect any external equipment (such as a power meter sensor) from a sudden surge of RF power which might otherwise occur on power-up. After the Generator Controller has gone through its start-up procedure, leaving its peripherals in a "safe" condition, the Generator Controller turns on the DC supply to the modules. If the Generator Controller is reset manually (without turning its power off), the DC power supply is unaffected (and remains on).

On reset, the ASX-16's RF attenuators are automatically set to 81 dB. If the ASX-16 is part of a Model DTS, the Generator Controller briefly "exercises" the RF coaxial relays in the switch/test fixture, resulting in a distinctive series of audible "clunks" from the switch/test fixture.

The Generator Controller receives its commands through the IEEE-488 bus. If a command is received which requires a response from the ASX-16, the Generator Controller responds through the IEEE-488 bus. Section II of this manual covers the IEEE-488 operations of the ASX-16.

## -2.3. Generator Controller Wiring

Figure 1-4 illustrates how the signals generated by the ASX-16 are used. The Bank Select lines identify the portion of the ASX-16 which is to receive the data signals (the data signals appear on Output lines D0 through D3). When a multi-circuit portion of the ASX-16 is involved, LS0 through LS3 more specifically identify the intended recipient of the signals. Output lines D3 through D7 go to the Modulation Generator. When the level of Output line D6 is low, the Modulation Generator transmits the standard 15.75 kilohertz modulation signal. When D6 is high, the Modulation Generator transmits a level-shifted duplicate of the data on Output line D7. When the Modulation Generator is running normally (D6 low), Output lines D5 and D4 can be used to halt the Modulation Generator, with its output held either high or low. The serial data stream (produced when Output line D6 is high) is sent to the modules. This data carries three fields of information: an 8-bit identification field, a four-bit control field, and a 12-bit carrier amplitude field. This twenty-four bit stream of information is used to turn on and off each module's carrier and modulation and to control the carriers' output levels.

Output lines D0 through D7 carry signals which are rarely held in a steady-state condition, except for the idle period during which the ASX-16 is waiting for a command from the IEEE-488 bus.

## -2.4. RF Generator Modules and Module Driver

The schematic of the ASX-16 Generator module is illustrated in Figure 1-6. Certain components have been left unspecified, because these values are determined by the frequency of operation (and are different for different modules).

Each module can be independently turned on and off, modulated or operated in a CW (unmodulated) mode. When a carrier is modulated, the modulating signal is provided by the ASX-16's Modulation Generator. The modules are controlled by the Module Driver board. The generator modules are arranged in banks of 16. Each bank is driven by a pair of identical Module Driver boards, which differ only in the way the Bank SElect Plug is installed. The schematic of the Module Driver is illustrated in Figures 1-5A and 1-5B.

The heart of each module is its RF section. The fine-tuning of the RF circuitry is accomplished through the use of variable capacitors. Although these adjustments are usually performed only at the factory, adjustments can be made by the customer, if required. The variable capacitor closest to the front panel adjusts the operating frequency of the module. The remaining adjustments fine-tune the filters in the RF amplifier chain which follows the oscillator. These variable capacitors are adjusted to bring the output amplitude to a peak. Do not confuse the module's adjustments with those of the filter. The filter is mounted on the back of the module, farthest away from the ASX-16's front panel. No adjustments should be attempted on the filter.

After a module has been re-tuned, its operation must be checked by the following procedure:

1) Using a frequency counter, verify the operating frequency of the module. The module's carrier should be set for CW (unmodulated) operation. Make sure all other modules are off and that the level reaching the input of the frequency counter is high enough for reliable operation.

2) Examine the carrier on the 1 dB-per-step scale of a spectrum analyzer. Note the carrier's exact amplitude and look for any signs of instability. If all is well, continue on to Step 3); otherwise, go back and re-adjust the module.

3) Using the QOFF mode (not the QLOW mode, which is the ASX-16's default mode), turn off all carriers, then turn back on the module you have just adjusted. Again, examine the frequency and amplitude of the carrier. If any change in amplitude or instability is noted, or if the module fails to activate, the module will have to be re-adjusted. If the module's oscillator stalls, shifts frequency, or fails to come on, its frequency may have to be slightly **mis-adjusted** to insure reliable operation. A module whose frequency is slightly off from its optimum value will not cause errors in distortion measurements.

4) Repeat Step 3) several times to insure that the module always comes on at the same frequency, the same amplitude, and that both frequency and amplitude are constant over time.

### -2.5. The Relay/Attenuator Driver Boards

The Model ASX-16 Relay/Attenuator Diver is illustrated in Figure 1-7. The operations of the our-bit RF Attenuator latches and drivers are identical to those on the Model DTS Relay/Attenuator Driver board described in the next paragraph.

The Model DTS Relay/Attenuator Driver board is illustrated in Figure 1-7. Each of the four-bit latches inverts the sense of the signal it receives. The two RF Attenuator latches and the Noise Source latch are used alone--that is, only one of these latches is addressed at a time. The remaining four latches are addressed in pairs, and are used to control the coaxial relays in the switch/test fixture. This "pairing" provides the "differential" drive required by the coaxial relays. A coaxial relay is flipped to one side by applying a differential across its leads of approximately 28 volts. If the polarity of this signal is reversed, the relay flips to its other side. The coaxial relays are self-latching, eliminating the need to apply a continuous control voltage to its leads. For this reason, power is applied to the relays for only a brief time (each time a relay command is received).

The Auxiliary Relay Driver board (illustrated in Figure 1-8) drives additional relays, including the coaxial GFIN/GFOUT and GA/GB relays.

## 2.6. Modulation Generator

The Modulation Generator's schematic is illustrated in Figure 1-9. This heart of this circuit is a ystal oscillator followed by a frequency divider. In most units, the oscillator operates at 15.75 legahertz; its output frequency is divided by one-thousand, to 15.75 Kilohertz. This signal is then assed, in a daisy-chain fashion to all the generator modules.

## 2.7. Receiver Controller

The circuitry of the Receiver Controller is identical to the circuitry in the Generator Controller, escribed in Section 1-2.1. The functional differences between the two Controllers are in the tilization of their Input/Output ports (see Sections 1-2.8. and 1-2.9. for details on the Input/Output of ne Receiver Controller). The schematic of the Receiver Controller is illustrated in Figure 1-10.

## 2.8. Operation of the Receiver Controller

On power-up (or reset), the Receiver Controller sets the AR-12's RF attenuator to 50 dB to rotect the Receiver from possible overload. It also deselects the filter bank (in other words, none of ne filters are selected). The Zero Correction Factors (ZSXT and ZC) are automatically set to "0.0" on ower-up or reset (see Section 2-4 for information on the Zero Correction Factors).

Whenever a distortion reading is initiated, or when a filter is selected using the "F" command, ne Receiver Controller immediately enables the filter specified by the command, and disables all thers.

There are two modes of operation in the AR-12: "normal mode", and "return to zero mode." In ne "normal mode," when the AR-12 is told to perform a distortion measurement, it first checks the AGC HIGH and AGC LOW lines to determine whether the received RF signal's amplitude is within ne AGC "window." If it is not, the AR-12's RF attenuator is adjusted (if possible) to bring the signal ithin the window. Under certain conditions, the RF Attenuator may be set to a value that is higher nan what is actually required for proper operation (this situation may result in degraded signal-to-oise conditions). This situation can occur because the AGC window is wider than 10 dB, but the RF ttenuator can only be adjusted in 10 dB steps--thus excess RF attenuation may be used, even though ne signal is within the Receiver's AGC window. Although all readings made under this condition are alid, distortion readings made near the "**noise floor**" limits of the AR-12 may be degraded. When eadings are to made of low-distortion devices (devices whose distortion readings will be close to the noise floor," it is best to use the "return to zero mode." In the "return to zero mode," when the AR-12 told to perform a distortion measurement, it first sets its RF attenuator to 0 dB (producing the trongest possible signal at the Receiver's input). The Receiver Controller then checks the AGC IIGH line, as above, to determine whether the received RF signal's amplitude is within the AGC window." If it is not, the AR-12's RF attenuation is increased to bring the signal within the window. The "return to zero mode" uses the **minimum** RF attenuation required for a proper distortion reading. As a result, distortion readings near the "noise floor" are improved, because the best signal-to-noise onditions are always used.

It is important to note that the Receiver Controller looks at the AGC comparitors only at the **tart** of a distortion reading. Should the RF signal level change during or after a distortion reading, the Receiver Controller will ignore the change.

Once the Receiver Controller has determined that the input RF amplitude is correct, the Controller sets the Audio (distortion) Attenuators to 64 dB. The Controller then checks the ppropriate feedback signals (either from the Composite Triple Beat Processor, or from the Commutative Filter Processor) to determine in which direction the Audio Attenuators should be

noved (more attenuation, less attenuation, or leave attenuation as is). In order, the 64, 32, 16, 8, 4, 2, , and .5 dB Audio Attenuators are adjusted until the selected Processor indicates that the Audio ttenuators are set correctly. The amount of Audio attenuation required to bring the input signal into ne "window" is a direct indication of the distortion's amplitude.

### -2.9. Receiver Controller Wiring

Figure 1-11 illustrates how the signals generated by the AR-12 are used. Output lines )0 through D7 are used to transfer the data to the Distortion Attenuator, the RF Attenuator, and to he Filter Selector board(s). Note that these are not the same D0 through D7 which make up the CPU's data bus--these Output lines are latched, buffered signals. The CPU's data bus is used xclusively on the Receiver Controller board, and does not have connections off the board. Output ines LS0, LS1, and LS2 select which part of the AR-12 will receive the data appearing on Output lines )0 through D7.

Output lines D0 through D7 are rarely held in a steady-state condition, except for the idle )eriod during which the AR-12 is waiting for a command from the IEEE-488 bus.

### -2.10. Receiver Filter Selector

The schematic for the Receiver Filter Selector is illustrated in Figure 1-12. An AR-12 normally as two Filter Selector Boards (one switches the filters' inputs; the other switches their outputs); nowever, more boards are used in units which contain more than sixty filters (or in units which contain nultiple banks of closely-spaced filters). When an AR-12 has more than sixty filters, the Filter Selector )oards which drive the second bank of filters contain **reversed** Bank Select jumper strips.

The filter number requested via an IEEE-488 command does not necessarily agree with the )hysical location of that filter. In general, the filters in an AR-12 are installed in ascending frequency )rder, regardless of the identification number assigned to them.
For example, if a five-filter AR-12 contained filters for channels 2, 3, 5, 7, and 9, these filters would be ocated in positions 1, 2, 3, 4, and 5, respectively.

The address of the selected filter is stored in a latch on the Filter Selector boards. The filter whose decoded address matches the latched data is enabled. If no filter match exists, no filter is selected.

## 2.11. Receiver Attenuator Latch Board

The schematic of the Receiver Attenuator Driver Board is illustrated in Figures 1-13A and 1-13B.

The AR-12 contains two types of attenuators: Distortion (Audio) Attenuators and RF Attenuators. The Distortion Attenuators are located in the RF Box (see Section 1-2.12), and can be set for any value between 0 and 127.5 dB, in .5 dB steps. The RF Attenuators can be set to any value between 0 and 70 dB, in 10 dB steps.

Data from the Receiver Controller is latched into the appropriate portion of The Attenuator Driver board (Figure 1-13A). The RF Attenuator requires additional drive capability, which is supplied by the circuitry illustrated in Figure 1-13B.

## 2.12. Receiver RF Box

The RF Box's schematic is illustrated in Figures 1-4A, 1-4B, and 1-4C. The RF Box contains an RF amplifier incorporated with an AGC (Automatic Gain Control) circuit. This allows the amplifier to produce a constant-level output, even if the input amplitude varies. The RF Box provides two signals, MORE ATTENUATION and LESS ATTENUATION, which tell the Receiver Controller to correct the value of the Receiver's RF Attenuator (if possible) if the input amplitude is outside the RF Box's AGC range.

The RF amplifier's output is level-detected, producing a signal which contains the audio-frequency Distortion which is to be measured. The detected signal is first passed through an Audio Attenuator, which can be set for any value from 0 to 127.5 dB, in .5 dB steps. This Attenuator is composed of eight sections: 64 dB, 32 dB, 16 dB, 8 dB, 4 dB, 2 dB, 1 dB, and .5 dB. The 64 dB step is made from two 32 dB steps (in series). The attenuated signal is then passed to the two Audio Distortion Processors for further processing (see Sections 1-2.14 and 1-2.15 for details).

## 2.13. Receiver Tone Generator

The schematic of the Tone Generator is illustrated in Figure 1-15. The Tone Generator is a high-gain audio amplifier, which extracts the residual modulation (distortion beat note) which modulates the input RF carrier(s). This signal is then amplified, raising it to a level usable by the Commutative Filter Processor (see Section 1-2.14).

## 2.14. Commutative Filter Processor

The Commutative Filter Processor's schematic is illustrated in Figure 1-16. The audio distortion beat note received from the Tone Generator is amplified further, then fed to a phase-locked loop. This loop free-runs at approximately to 15 to 16 Kilohertz. In the presence of a Tone Generator signal, the phase-locked loop locks its operating frequency onto the phase and frequency of the input signal.

The Audio (Distortion) signal received from the RF box is amplified by the Commutative Filter Processor's amplifiers, producing a signal which is in-phase, and another signal which is one-hundred-eighty degrees out of phase. These two phases are split into four phases, using the output waveforms generated from the phase-locked loop's output. The result of this processing is the synchronous subdivision of the Distortion signal into four quadrature (every 90 degrees) components. The quadrature components are then combined and amplitude-detected. The output of this detector is fed

o a window comparitor, which determines whether the resulting, detected signal is too large, too small, r acceptable. The output signals "MORE ATTENUATION" and "LESS ATTENUATION" are outed back to the Receiver Controller, where they are used to determine if the Audio (Distortion) ttenuators need to be adjusted. The Receiver Controller alters the amount of Audio attenuation ntil neither the "MORE ATTENUATION" nor the "LESS ATTENUATION" signals are active.

### -2.15. Composite Triple Beat Processor

The Composite Triple Beat Processor's schematic is illustrated in Figure 1-17. This circuit onsists primarily of an audio amplifier and a broad-band audio filter, followed by an amplitude etector and a window comparitor. The detector and window comparitor function identically to those escribed in Section 1-2.14.

## -3. Repairs to the Equipment

Repairs to the Model ASX-16 and AR-12 are discussed in the next two sections. Because the Model DTS contains both an ASX-16 and an AR-12, these sections also apply to the DTS. Repairs to DTS system fall into five general categories:

1) Generator modules

2) Receiver RF Box

3) main frame harnessing

4) support equipment (Controllers, driver boards, et cetera)

5) equipment not manufactured by Matrix Test Equipment.

The first four groups are covered in the chapters, below. For repairs to equipment not manufactured by Matrix, consult the manuals supplied by the equipment's manufacturer.

### -3.1. Repairs to the Generator Modules

There are four ways in which a Generator module can fail:

1) unstable, intermittent operation or no output power

2) always CW (no modulation)

3) always modulated

4) improper response to L (Leveling) commands.

Any of these problems can be caused by bad continuity between the module and the control iring, power wiring, or coaxial cables. First check all coaxial connectors and wiring connections. lach module is controlled by one section of the Module Driver board. If the problem affects a half-ank of modules (8 interleaved modules) or an entire bank of modules (16 adjacent modules), the lodule Driver board(s) should be checked out first. Even if a problem seems to be unique to a single lodule, the malfunction may still be located on the Module Driver board. Before assuming the roblem is in the module, swap the Module Driver board connections between the "defective" module nd an adjacent (working) module. If the problem moves to the other channel, the problem is on the lodule Driver board.

If there is a break in any of the coaxial cabling (which is daisy-chained from module to module), l modules following the break will exhibit the same bad characteristics.

Another cause of no output (or intermittent output) is a stalled (or intermittently stalling) scillator. Carefully re-tune the module, as described in Section 1-2.4. Do not confuse the module's djustments with those of the filter. The filter is mounted on the end of the module, furthest away om the panel. Do not alter the filter adjustments.

If the malfunction still exists after checking for bad connections and for a stalled oscillator, the odule will have to be removed from the ASX-16. After opening the module's case, look for any bvious signs of damage, such as a charred component, or a broken connection. Although repairs can metimes be made by the customer, it is advised that any malfunctioning modules be returned to latrix Test Equipment for repairs.

### 3.2. Repairs to the Receiver's RF Box

The RF Box contains three basic sections:

1) RF Amplifier, AGC circuit, and Audio Detector

2) Audio Attenuator

3) AGC Comparitors.

Section 1-2.12 describes the operations of these devices. Proper operation of the RF Amplifier, GC circuit, and Audio Detector can most easily be checked by commanding the AR-12 to perform a stortion reading on a strong, 100% modulated carrier. When these circuits are functioning properly, e output of the audio detector (which will look like a 15.75 Kilohertz square wave) will remain bsolutely constant as the input level is varied over a +/- 5 dB range. If no signal is seen, the RF mplifier or Audio Detector has failed. If the amplitude varies, the AGC circuit has failed. Make sure l control, power supply, and coaxial connections to the RF box are good. Under the same test onditions described above, the Receiver Controller will set most of the Audio Attenuator inputs high. nly the least significant few Attenuators may be low. If you suspect the Audio Attenuator is alfunctioning, the operation of its individual sections can be checked using the following procedure:

1) With power to the RF Box removed, disconnect the wire which controls the suspected Audio Attenuator Section. Replace this connection with a 470 Ohm resistor in series with an external power supply. The power supply's output should be set to between +3.5 and +5.0 Volts DC. The 470 Ohm resistor **must** be placed between the power supply and the input of suspect Audio Attenuator, or the RF Box will be damaged. Make sure the power supply is off while the connections are made.

2) Restore power, turn on the external power supply, then perform a distortion measurement on a strong, 100% modulated carrier. The data produced from the distortion reading may be in error.

3) With an oscilloscope, examine the output of the RF Box. Turn the external power supply on and off. The Audio Attenuator connected to the power supply should affect the displayed amplitude by an appropriate amount. For example, if you are testing the 8 dB Attenuator, the audio output signal should change by precisely 8 dB as the voltage is turned on and off.

The AGC comparitors are only read by the Receiver Controller when a distortion reading is :ing made. When no reading is in progress, the outputs of the comparitors are ignored. The :mparitors' operation can be checked by applying very strong and very weak inputs to the AR-12. ake sure the AR-12's RF Attenuator is set for 0 dB by sending the AR-12 command, "A0" (zero). rong and weak signals should activate the MORE ATTENUATION and LESS ATTENUATION gnals, respectively; moderate levels will leave both signals deactivated.

### 3.3. Repairs to Main Frame Harnessing

The main frame harnessing for the ASX-16 and AR-12 are illustrated in Figures 1-20 and 1-21, spectively. Only a small portion of the coaxial connections is shown in these diagrams. Coaxial nnections can be inferred from Figures 1-1 and 1-2. The main frame harnessing for the ASX-16 rtion of the Model DTS is shown in Figure 1-20A.

If a signal which appears at its designated source is not appearing at its destination, first make re that all plugs are firmly seated and that they are installed in the correct location and in the correct irection. It is possible (through vibration) for plugs to eventually work themselves up, off their mating ins. This is especially likely after the equipment has been subjected to the rigors of shipping.

If all connections seem tight, check for continuity, from source to destination, using an Ohm eter or other continuity tester. If the signal path is continuous, check for shorts to **adjacent** pins on ll connectors which contain the "faulty" signal. Finally, check for shorts to ground. Many signals pass rough feed-throughs. A feed-through can short to ground if it becomes cracked due to mechanical ress, or if it becomes damaged, due to the use of excessive heat when its wires are soldered or de-oldered.

### -3.4. Miscellaneous Repairs

Most of the circuitry in the ASX-16, AR-12, and DTS can be repaired by consulting the ppropriate sub-section (and its referenced schematic) in Section 1-2. Once the proper operation of he circuitry is understood, repairs can be made by tracing the signal paths in the suspected device using an oscilloscope or logic analyzer), or by substituting integrated circuits (ICs) and other omponents. The only ICs which cannot be substituted for, using commercially-available components, re the PROMs on the ASX-16 and AR-12 Controller boards. Replacement PROMs for your quipment are available from Matrix Test Equipment.

## SECTION II

## IEEE-488 (GPIB) OPERATING INFORMATION

### 2-1. Introduction

The Model ASX-16 contains a bank of Generator Modules (with attached filters), a Modulation Generator, and a programmable RF attenuator (1 dB to 81 dB). The operation of these items can be remotely controlled, as detailed in sections 2-2 and 2-3. The block diagram of Figure 1-1A illustrates the ASX-16's major interconnections.

The Model AR-12 contains a bank of RF filters, a programmable RF attenuator (10 dB to 70 dB), an RF-frequency processor, and an audio-frequency distortion analyzer. The operation of these items can be remotely controlled, as detailed in section 2-4. The block diagram of Figure 1-1B illustrates the AR-12's major interconnections.

The Model DTS contains the circuitry from a Model ASX-16 and a Model AR-12, plus additional RF relays and amplifiers. These coaxial relays, plus the ones contained in the "white box" (switch/test fixture) are controlled by the ASX-16 portion of the DTS, as detailed in sections 2-2 and 2-3. The block diagram of Figure 1-1C illustrates a typical DTS's major interconnections. Information on controlling any additional DTS equipment can be found in the manuals provided by the equipment's manufacturers.

### 2-2. Features of the ASX-16

The ASX-16 contains a bank of crystal-controlled modules which can be individually turned on, turned off, 100 percent modulated with a 15.75 KHz square wave, set for CW (no modulation), and output-level adjusted over approximately a 7 dB range. The output of this module bank is passed through an RF attenuator, which can be varied over a range of 0 to 81 dB in 1 dB steps.

If your Model DTS is equipped with a Frequency Synthesizer, special ASX-16 commands allow its signals to be used separately, or to be combined with the carrier signals from the ASX-16. This feature is used when making Composite Second Order Beat and Discrete Second and Third Order tests.

If your Model DTS is equipped with a noise source, the noise source can be switched in and out of the system through special ASX-16 commands.

In the Model DTS, a Power Meter or a Spectrum Analyzer is used to measure RF power. The power-measuring device can be used to measure (and adjust) the individual ASX-16 generator output levels, as well as the output level of the Frequency Synthesizer (if one is included). The additional RF relays in the DTS allow the instantaneous re-configuring of the DTS system from one test to another, without the need to physically move any cables.

## 3. Software Interface for the ASX-16

There are two types of commands which can be sent to the ASX-16: SLAVE commands and HANDSHAKE commands. All valid SLAVE commands are executed as soon as they are received. The HANDSHAKE commands utilize two-way communications. In practice, the host computer (IEEE-488 system controller) sends a HANDSHAKE command to the ASX-16, then the host computer reads the ASX-16's response. This "handshake" **must** be completed (by reading the ASX-16's response). If the ASX-16's response is not read, the ASX-16's interface to the IEEE-488 bus will be locked up.

Any spaces in received commands are ignored. Commands **to** the ASX-16/AR-12 can contain either UPPER CASE or lower case letters. Commands **to** the ASX-16/AR-12 can be terminated with either a "carriage-return/line-feed" (ASCII code 13 followed by ASCII code 10), or with just a "line-feed" character. Responses **from** the ASX-16/AR-12 will be terminated with a "carriage-return" (only) on power-up (or after a reset). If the host computer (customer's equipment) requires a "carriage-return/line-feed" termination, the output character sequence from the ASX-16/AR-12 can be changed by using the OUTCRLF command. The OUTCRLF and OUTCR commands are described in this Section for the ASX-16, and in Section 2-4 for the AR-12.

Whenever "+/-" appears in the chart below, it indicates that an **unsigned** number will be assumed to be positive, and a number preceded by a "-" sign will be taken as negative. Do not include a "+" in front of numerical data which is supposed to be positive. For example, negative 12 is sent as "-12"; positive 12 is sent as "12".

When a module number is indicated in the following command chart, the module number should be an integer from 1 to N (where N is the highest module number in your system--N has a maximum value of 255). If a module number of 0 (zero) is used (on commands where such a value is permitted), the command is applied simultaneously to **all** modules in the ASX-16. Table 2-1 of this manual indicates the relationship between module number and the generated/received frequency of the module.

The chart starting on the next page lists the commands available in the ASX-16. The ASX-16 portion of a Model DTS contains additional commands which are generally not available on a standard Model ASX-16. Commands unique to the Model DTS will be identified as DTS commands.

Some commands may be unavailable in your Model ASX-16 or DTS. Commands which require optional equipment are marked "(optional)".

In the following chart, command literals are indicated in **UPPER CASE**; variables are indicated in **lower case.**

| GNAL | MEANING | TYPE | EXAMPLES |
|---|---|---|---|
| data | sets the ASX-16's RF Attenuator to to the value of the "data" (in dB) in 1 dB steps over a range of 0 to 81 dB. When the ASX-16 is reset, the RF attenuator is set to 81 dB. | SLAVE | A20<br>A11 |
| V | requests the Value of the ASX-16's RF Attenuator setting. The response from the ASX-16 is a three-digit number (with leading zeros, as necessary) from 000 to 081. The extra digit allows for the future use of attenuators whose maximum value may exceed 99 dB. | HANDSHAKE | AV |
| module | applies power to the specified module and sets the module for CW (unmodulated) operation. If the module number is 0 (zero), all modules are set for CW operation (the normal arrangement of carriers for a Composite Triple Beat Test). | SLAVE | C1<br>C100<br>C0 |
| +<br>ptional) | in a Model DTS, sets the polarity of the DC power going to the device under test to be positive on the (+) power terminal and negative on (-) ground terminal (forward polarity). | SLAVE | G+ |
| -<br>ptional) | in a Model DTS, sets the polarity of the DC power going to the device under test to be negative on the (+) power terminal and positive on (-) ground terminal (reversed polarity). | SLAVE | G- |
| A<br>ptional) | in a Model DTS, sets the "G" relays to route RF power from the synthesizer, **Alone**. | SLAVE | GA |
| B<br>ptional) | in a Model DTS, sets the "G" relays to route RF power from **Both** the ASX-16 modules and the synthesizer. | SLAVE | GB |
| FIN<br>ptional) | in a Model DTS, switches the frequency counter into the RF path. | SLAVE | GFIN |

**NOTE:** Due to strong signals generated by the frequency counter which can interfere with other equipment, the frequency counter must be switched OUT, except when frequency measurements are made.

| GNAL | MEANING | TYPE | EXAMPLES |
|---|---|---|---|
| FOUT<br>ptional) | in a Model DTS, switches the frequency counter out of the RF path. | SLAVE | GFOUT |
| | requests the ASX-16's customer-programmed identification number. This ID number is programmed by setting the "CUSTOMER DEVICE IDENTIFIER" switches on the ASX-16's Microcontroller board. The response from the ASX-16 is a three-digit number from 000 to 099. | SLAVE | I |
| ptional) | requests the status of the test module switch (located on the test/switch fixture). Response from the ASX-16 is either N (switch is open), or G (switch is closed). | HANDSHAKE | K |
| module,+/-steps | sets the indicated module's carrier Level up (unsigned) or down (minus sign) by the requested number of steps. Each step is approximately .1 to .2 dB. Note that the comma (,) must be sent. The response from the ASX-16 is either an "N" for "no-go" (cannot move by that number of steps) or a "G" for "go" (can move by that number of steps). When a module's level is changed, its carrier is automatically turned on CW.<br><br>When the specified module number is 0 (zero), indicating **all** modules, if **any** module cannot be stepped by the requested amount, an N response is generated, and no levels are changed. | HANDSHAKE | L12,15<br>L12,-15<br>L0,75<br>L0,-75 |
| **NOTE**: | Each module has a range of approximately 7 dB which is covered by 255 steps (from 0 to 255). The change in dB per step varies from module to module. The change in dB per step also varies over the adjustable range of each module. After a reset, each module is set to step 128. | | |

| SIGNAL | MEANING | TYPE | EXAMPLES |
|---|---|---|---|
| LMmodule | requests the step Level of the specified Module. Response from the ASX-16 is a 3-digit number (with leading zeros, as necessary) from 000 to 255. | HANDSHAKE | LM1<br>LM100 |
| Mmodule | applies power to the specified module and sets the module for 100% Modulated operation. If the module number is 0 (zero), all modules are set for 100% Modulated operation. | SLAVE | M1<br>M100<br>M0 |
| NON<br>(optional) | in a Model DTS, applies power to the Noise Source. | SLAVE | NON |

**NOTE:** The NON and NOFF commands affect **only** the power to the Noise Source. The R command (see below) must be used to switch the Noise Source into and out of the RF circuit.

| | | | |
|---|---|---|---|
| NOFF<br>(optional) | in a Model DTS, removes power from the Noise Source. | SLAVE | NOFF |
| OUTCRLF | changes the output termination characters for data **transmitted from** the ASX-16 to be "carriage-return/line-feed". | SLAVE | OUTCRLF |

**NOTE:** The OUT commands do not affect the requirements for data **to** the ASX-16. Commands **to** the ASX-16 can be terminated with either a "carriage-return" followed by a "line-feed", or with just a "line-feed".

| | | | |
|---|---|---|---|
| OUTCR | changes the output termination character for data **transmitted from** the ASX-16 to "carriage-return" (only). See the NOTE, above. This is the reset/power-up default mode. | SLAVE | OUTCR |
| Pmodule | shuts "off" the carrier of the specified module in accordance with the mode set by the Q command (see below). If the module number is 0 (zero), the carriers of all modules are shut "off." | SLAVE | P1<br>P121<br>P0 |

| SIGNAL | MEANING | TYPE | EXAMPLES |
|---|---|---|---|
| QLOW | sets the Quality factor of the "off" discussed in the P, S, and T commands. In the QLOW mode, all "off" carriers are unmodulated, with their amplitudes at least 35 dB lower than normal. Activating the QLOW mode does **not** affect the pre-existing conditions of the modules. The QLOW command affects only those modules which are **subsequently** turned "off" using the P, S, or T command. The ASX-16 powers-up in the QLOW mode. | SLAVE | QLOW |
| QOFF | sets the Quality factor of the "off" discussed in the P, S, and T commands. In the QOFF mode, all "off" modules have their power removed. In this mode, the oscillators will "cool off" (that is, if a module is left "off" while the QOFF mode is active, it will not be at its "warmed-up" frequency when power is reapplied). Activating the QOFF mode does **not** affect the pre-existing condition of the modules. The QOFF command affects only those modules which are **subsequently** turned "off" using the P, S, or T command. | SLAVE | QOFF |
| Rdata (optional) | in a Model DTS, configures the "R" relays in the "white box" (the test/switch fixture). The "data" portion of the command specifies the new positions for the "white box" relays.<br><br>In the standard Model DTS, There are eight (8) "R" relays (or sets of relays). Additional relays can be added (see the next page).<br><br>In the "data" portion of the command, positions are specified, in order, relay 1 first, relay 8 last. **All eight of the relays must be specified,** even if their positions do not matter in the particular test configuration; even if your "white box" does not contains the full set of eight relays. "U" puts a relay in its Up position. "D" puts a relay in its Down position. "X" indicates that the relay's position is unimportant. | SLAVE | (see below) |

| SIGNAL | MEANING | TYPE | EXAMPLES |
|---|---|---|---|
| | Examples are shown using eight relays. If your DTS has more than eight relays, the additional data should be placed after the eight character of the "data." (Example for ten relays: RUDDUXDDUUU)<br><br>The following examples are based on the circuitry of Figure 1-2. If your "white box" is configured differently, these examples may not apply. | | |
| RUDDUXDDU | connects the combined ASX-16 and/or Frequency Synthesizer outputs to the input of the device under test. The output of the device under test is connected to the input of the AR-12 Distortion Analyzer. This configuration is used to make X-mod, Discrete Second and Third Order, and Composite Triple Beat tests. | SLAVE | |
| RUUUUXUXX | connects the combined ASX-16 and Frequency Synthesizer outputs to the input of the Power Meter. This configuration is used when measuring input power levels. | SLAVE | |
| RUDUUXUDX | connects the combined ASX-16 and Frequency Synthesizer outputs to the input of the device under test and connects the output of the device under test to the input of the Power Meter. This configuration is used when measuring output power levels. | SLAVE | |
| RUDUDUUDD | is used when making input return loss measurements. | SLAVE | |
| RUDUUXUUU | is used when making output return loss measurements. | SLAVE | |
| RDDDDUUDU | is used when making noise figure measurements. | SLAVE | |
| RUUDUXDDU | is used when making "noise floor" measurements. This is a test mode which helps to establish if the DTS system is working properly. | SLAVE | |

| SIGNAL | MEANING | TYPE | EXAMPLES |
|---|---|---|---|
| Smodule,module | turns "off" all modules except the two specified in the command. These two are set to CW (unmodulated) operation. The S command is used for setting up the ASX-16 for a Second Order distortion test. The Frequency Synthesizer (used to generate the frequency-offset carrier) is set up separately. Note that the comma (,) must be sent. | SLAVE | S28,37<br>S2,112 |
| SMmodule (optional) | requests the operating mode of the specified Module. Response from the ASX-16 is always a three-character string. For CW (unmodulated) operation, the response is "CW " (including one blank space). For modulated operation, the response is "MOD". For power off (non-operation), the response is "OFF". For power low (-35 dB down, or more), the response is "LOW". | HANDSHAKE | SM1<br>SM100 |
| Tmodule,module,module | turns "off" all modules except the three modules specified in the command. These three are set to CW (unmodulated) operation. The T command is used for setting up the ASX-16 for a discrete Third Order distortion test. The Frequency Synthesizer (used to generate the frequency-offset carrier) is set up separately. Note that the comma (,) must be sent. | SLAVE | S6,8,9<br>S2,41,42 |
| V+/-data | Varies the RF Attenuator by the amount (in dB) specified by the data. The ASX-16 responds with an N if the attenuator cannot be varied by the requested amount, or with a G if the attenuator can be varied by the requested amount. | HANDSHAKE | V12<br>V-12 |
| Xmodule | turns on all modules in the 100% modulated mode, except for the specified module, which is instead set for CW (unmodulated) operation. The X command is used for making X-mod (Cross-modulation) tests. | SLAVE | X1<br>X13<br>X101 |

## -4. Features and Software Interface for the AR-12

The AR-12 is a receiver/distortion analyzer containing a bank of RF filters. The filters are ctivated one at a time. The selected filter determines the frequency on which a distortion ieasurement is made. An optional RF preamplifier is available which can be used to increase the \R-12's sensitivity.

There are two methods for making distortion measurements on the Model AR-12: **absolute** nd within-specifications (**within-spec**). With the absolute method, the AR-12 returns a number which epresents the actual distortion read by the AR-12. This process takes approximately five seconds (if he received signal is within the range of the AR-12's AGC circuitry). With the within-spec method, he AR-12 returns a "G" (for good) if the measured distortion is less than or equal to the "spec;" it eturns an "N" (for no-good) if the measured distortion is greater than the "spec." The within-spec )rocess takes approximately two seconds (if the received signal is within the range of the AR-12's AGC ircuitry).

The AR-12's receiver has an Automatic Gain Control (AGC) circuit which can handle a broad ange of input levels. The AGC circuit is further aided by the AR-12's microcontroller, which will ıutomatically change the AR-12's input RF attenuator to bring the input level within the capabilities )f the AGC circuitry, if possible. For every change of the RF attenuator, the AR-12 pauses ıpproximately one second to allow the AGC circuitry to settle.

If the received signal cannot be brought into AGC range, the AR-12 will transmit an "N" as the first character in the distortion reading, or an "N" in response to a within-spec command. Any data transmitted with an "N" preceding it has no practical meaning.

When the AR-12 is first powered up or reset, the distortion readings it transmits are ıncalibrated (and are in error). These readings contain an offset, called the Zero Correction Factor. After the appropriate correction factors have been transmitted to the AR-12, all subsequent distortion eadings will be correct. On power-up and after a reset, the Zero Correction Factors are automatically eturned to zero (0). Note that within-spec commands will not function correctly until after the AR-12 ıas been calibrated.

There are two distortion processors in the AR-12: the Commutative Filter Processor (used for X-mod and Discrete Second-Order and Third-Order measurements) and the Composite Triple Beat Processor (used for CTB and Composite Second Order measurements). These processors have **different** Zero Correction Factors, and are calibrated separately. When an X-mod reading is made on a lone, 100% modulated carrier, **before** the Commutative Filter Processor has been calibrated, a non-zero number will be generated by the AR-12. This non-zero number is the Zero Correction Factor for the Commutative Filter Processor. Similarly, if a CTB reading is made on a lone, 100% modulated signal **before** the CTB processor has been calibrated, the AR-12 will generate a non-zero number, representing the CTB Processor's Zero Correction Factor. The calibrating procedure is outlined in the four-step procedure provided below. Step 1 can be skipped if the AR-12 has just been powered up or reset. See the AR-12 command chart below for an explanation of the commands. Consult Section 2-3 for details on ASX-6/AR-12 IEEE-488 bus communications.

**AR-12 Calibration Procedure:**

1) Send the following two SLAVE commands to the AR-12:

ZSTX0.0 <--- zero decimal-point zero
ZC0.0 <--- zero decimal-point zero

This removes any prior calibration factors from the AR-12's memory.

2) Set the ASX-16 for all modules off except one. That module should be 100% modulated. Select a module which has a corresponding filter in the AR-12. In the Model DTS, the RF relays must set to an appropriate configuration (see the ASX-16 commands in Section 2-3 for details).

3) Send the following two HANDSHAKE commands to the AR-12. Make sure the handshake for the first command is completed before you send the second command (in this example, we assume that module/filter 2 is being used):

X2 (assume the response was -12.5)
C2 (assume the response was -21.0)

4) Send the following two SLAVE commands to the AR-12 (the instructions shown here use the example responses from step 3; substitute the actual responses you received in step 3:

ZSTX12.5
ZC21.0

When a filter number is indicated in the following command chart, the filter number should be an integer from 1 to N (where N is the highest filter number in your system--N has a maximum value of 255). Table 2-1 (located between Chapters I and II) of this manual indicates the relationship between the module/filter reference number and its frequency.

The AR-12 communicates identically with the IEEE-488 bus as does the ASX-16 portion (including **SLAVE** and **HANDSHAKE** commands). Please consult Section 2-3 for information on the requirements for IEEE-488 bus communication.

The following commands are available on the AR-12 portion of the Model DTS (note that command literals are indicated in **UPPER CASE**; variables are indicated in **lower case**):

## AR-12 COMMANDS

| SIGNAL | MEANING | TYPE | EXAMPLES |
|---|---|---|---|
| Adata | sets the AR-12's RF Attenuator to the value of the "data" in dB, in 10 dB steps over a range of 0 to 70 dB. | SLAVE | A20<br>A0 |
| AV | requests the Value of the AR-12's RF Attenuator setting. The response from the AR-12 is a two-digit number (with leading zeros, as necessary) from 0 to 70. | HANDSHAKE | AV |
| Cfilter | causes a reading to be made of the Composite Triple Beat distortion using the specified filter. The AR-12 responds with a C, a minus sign, and then the distortion in dB (example: C-56.0). If the AR-12's AGC loop is not locked, the "C" in the response will be replaced by an "N" and the reading will be invalid (example: N-72.5). | HANDSHAKE | C1<br>C100 |
| Cfilter,spec | causes a within-spec Composite Triple Beat test to be made using the specified filter and using the specification as the decision point. Note that a positive integer is used for the "spec," that is, 60 dB down (-60 dB) is entered as a spec of 60. The response from the AR-12 is a G if the distortion is less than or equal to the spec. The response is an N if the distortion is greater than the spec, or if the AR-12's AGC loop is not locked. Note that the comma (,) must be sent. | HANDSHAKE | C1,55<br>C23,60 |
| Ffilter (optional) | causes the specified filter to be selected without any distortion measurement. | SLAVE | F1<br>F100 |
| FAmaxpos (optional) | causes the Model AR-12 to begin an **automatic** scanning of its filters, from the first position to the maximum position number which was specified by the data "maxpos". Note that this is the **position** number and not the **usual** module or filter designation (see example, below). | SLAVE | FA7<br>FA62 |

| SIGNAL | MEANING | TYPE | EXAMPLES |
|---|---|---|---|
| | Example: assume your Model AR-12 has thirty (30) filters with designations: 2,4,5,6,8,9,10,12,14,15,17,20,22,27,33, 42,44,45,46,48,49,50,52,54,55,57,60,62, 67,and 73. If you want a rapid scan of filter 2 (in the first position) through filter 55 (in the twenty-fifth position), use the command "FA25".<br><br>Scanning will continue **endlessly** until either the AR-12 is turned off or until the AR-12's RESET button is pressed.<br><br>This command is primarily intended for testing purposes. Typically, the output of an ASX-16 is connected to the input of the AR-12. All ASX-16 generator modules are turned on CW, then the commands "A0" and "FAmaxpos" are sent to the AR-12. The output of the AR-12's filter bank is then connected to the input of a rapidly-scanning spectrum analyzer, allowing the simultaneous display of all ASX-16 generator modules which have a corresponding AR-12 filter. | | |
| GZ | activates the "Go to Zero" Mode. When in this mode, the AR-12's RF attenuator will be automatically set to 0 (zero) dB before each distortion measurement is made. This mode guarantees the best possible signal-to-noise ratio for all measurements. For strong input signals, measurements may take slightly longer in this mode, due the additional time required for the AR-12 to restore the necessary RF attenuation. | SLAVE | GZ |

| SIGNAL | MEANING | TYPE | EXAMPLES |
|---|---|---|---|
| NM | activates the "Normal" Mode. When in this mode, the AR-12's RF attenuator is left at its former setting (unless a too strong or too weak signal is detected. This mode requires the least amount of time for repeated measurements on signals with similar amplitudes. NM is automatically selected after the AR-12 is powered-up or reset. | SLAVE | NM |
| OUTCRLF | changes the output termination characters for data **transmitted from** the AR-12 to be "carriage-return/line-feed". | SLAVE | OUTCRLF |
| NOTE: | The OUT commands do not affect the requirements for data **to** the AR-12. Commands **to** the AR-12 can be terminated with either a "carriage-return" followed by a "line-feed", or with just a "line-feed". | | |
| OUTCR | changes the output termination character for data **transmitted from** the AR-12 to be "carriage-return" (only). See the NOTE, above. This is the reset/power-up default mode. | SLAVE | OUTCR |
| PIN (optional) | places the optional RF preamplifier into the RF path of the AR-12. The preamplifier is used only when the device under test is incapable of providing sufficient signal for the AR-12 to function properly. | SLAVE | PIN |
| POUT (optional) | removes the optional RF preamplifier from the path of the AR-12. On units equipped with the pre-amplifier option, this is the mode automatically selected on power-up or after a reset. | SLAVE | POUT |
| Sfilter | causes a reading to be made of the Discrete Second Order distortion using the specified filter. The AR-12 responds with an S, a minus sign, and then the distortion in dB (example: S-56.0). If the AR-12's AGC loop is not locked, the "S" in the response will be replaced by an "N" and the reading will be invalid (example: N-72.5). | HANDSHAKE | S1<br>S100 |

| SIGNAL | MEANING | TYPE | EXAMPLES |
|---|---|---|---|
| Sfilter,spec | causes a within-spec Discrete Second Order test to be made using the specified filter and using the specification as the decision point. Note that a positive integer is used for the "spec," that is, 60 dB down (-60 dB) is entered as a spec of 60. The response from the AR-12 is a G if the distortion is less than or equal to the spec. The response is an N if the distortion is greater than the spec, or if the AR-12's AGC loop is not locked. Note that the comma (,) must be sent. | HANDSHAKE | S1,55<br>S23,60 |
| Tfilter | causes a reading to be made of the Discrete Third Order distortion using the specified filter. The AR-12 responds with a T, a minus sign, and then the distortion in dB (example: T-56.0). If the AR-12's AGC loop is not locked, the "T" in the response will be replaced by an "N" and the reading will be invalid (example: N-72.5). | HANDSHAKE | T1<br>T100 |
| Tfilter,spec | causes a within-spec Discrete Third Order test to be made using the specified filter and using the specification as the decision point. Note that a positive integer is used for the "spec," that is, 60 dB down (-60 dB) is entered as a spec of 60. The response from the AR-12 is a G if the distortion is less than or equal to the spec. The response is an N if the distortion is greater than the spec, or if the AR-12's AGC loop is not locked. Note that the comma (,) must be sent. | HANDSHAKE | T1,55<br>T23,60 |
| Xfilter | causes a reading to be made of the Cross-Modulation (X-mod) distortion using the specified filter. The AR-12 responds with an X, a minus sign, and then the distortion in dB (example: X-76.0). If the AR-12's AGC loop is not locked, the "X" in the response will be replaced by an "N" and the reading will be invalid (example: N-72.5). | HANDSHAKE | X1<br>X100 |

| IGNAL | MEANING | TYPE | EXAMPLES |
|---|---|---|---|
| Xfilter,spec | causes a within-spec X-mod test to be made using the specified filter and using the specification as the decision point. Note that a positive integer is used for the "spec," that is, 60 dB down (-60 dB) is entered as a spec of 60. The response from the AR-12 is a G if the distortion is less than or equal to the spec. The response is an N if the distortion is greater than the spec, or if the AR-12's AGC loop is not locked. Note that the comma (,) must be sent. | HANDSHAKE | X1,65<br>X23,80 |
| ZCdata | establishes the AR-12 Composite Triple Beat processor's Zero Correction Factor. The value of "data" is derived using the procedure outlined in Section 2-4 of this manual. | SLAVE | ZC13.5<br>ZC20.0 |
| ZC0.0 | removes any pre-existing CTB Zero Correction Factor. | SLAVE | ZC0.0 |
| ZSTXdata | establishes the AR-12 Commutative Filter processor's Zero Correction Factor. The value of "data" is derived using the procedure outlined in Section 2-4 of this manual. | SLAVE | ZSTX13.5<br>ZSTX20.0 |
| ZSTX0.0 | removes any pre-existing Commutative Filter Zero Correction Factor. | SLAVE | ZSTX0.0 |

## -5. Typical Distortion Tests

The examples in the next sections are written in Hewlett-Packard Basic, compatible with many IP computers. Some modifications may be necessary to adapt these programs for use with other omputers.

As shipped from the factory, the Model ASX-16 is set for IEEE-488 bus address 24, and the Model AR-12 is set for IEEE-488 bus address 23.

### -5.1. Zeroing the AR-12 Receiver

Section 2-4 provides the procedure to be followed when zeroing (calibrating) the AR-12. The ollowing sample program uses a similar procedure. In this example, module and filter number 28 ıave been arbitrarily selected. The Zero correction factors need only be set once after the AR-12 is )owered up or reset; however, periodic re-zeroing can also be performed.

```
10  REM  GENERATING THE ZERO CORRECTION FACTOR FOR THE AR-12
20  OUTPUT 723; "ZSTX0.0"
30  OUTPUT 723; "ZC0.0"
40  OUTPUT 724; "P0"
50  OUTPUT 724; "A5"
60  OUTPUT 724; "M28"
70  OUTPUT 723; "X28"
80  ENTER 723 USING "#,A,6*"; R$,D1
90  IF R$="N" THEN GOTO 1000
100  OUTPUT 723; "ZSTX"; ABS(D1)
110  OUTPUT 723; "C28"
120  ENTER 723 USING "#,A,6*"; R$,D2
130  IF R$="N" THEN GOTO 1000
140  OUTPUT 723; "ZC"; ABS(D2)
150  OUTPUT 724; "P0"
160  REM  (PROGRAM CONTINUES FROM THIS POINT)
1000 PRINT "INSUFFICIENT SIGNAL LEVEL ON MODULE 28"
1010 STOP
```

Lines 20 and 30 remove any prior AR-12 Zero Correction Factors.

Line 40 turns off all ASX-16 carriers.

Line 50 sets the ASX-16's RF attenuator to 5 dB.

Line 60 turns on the carrier of module 28 and sets it to 100% modulated operation.

Line 70 tells the AR-12 to perform an X-mod test with filter 28.

Line 80 tells the computer what kind of data it should expect to see, then reads the response from the AR-12. The "#" tells the computer not to wait for a "LINE FEED" character. The "A,6*" tells the computer to read a single alpha-numeric character, followed by a six-character numerical value. The alpha-numeric character is stored as R$; the numerical value us stored as D1. A typical response from the AR-12 would look like this:

X-012.5(CR)

where "(CR)" represents the CARRIAGE RETURN character.

Line 90 checks the value of R$. If everything is all right, R$ will be "X", but if insufficient signal appears at the input of the AR-12, R$ will be "N". In case of a problem, the program jumps to line 1000.

Line 100 sends the Commutative Filter Processor's Zero correction factor to the AR-12. After line 100 is executed, all X-mod, Discrete Second Order, and Discrete Third Order distortion readings will be automatically corrected.

Line 110 triggers the AR-12, telling it to perform a Composite Triple Beat test using filter 28.

Lines 120 and 130 are identical in nature to Lines 80 and 90. A typical response from the AR-12 would look like this:

C-024.5(CR)

where "(CR)" represents the CARRIAGE RETURN character.

Line 140 sends the Composite Triple Beat Processor's Zero correction factor to the AR-12. After line 140 is executed, all Composite Triple Beat distortion readings will be automatically corrected.

Line 150 turns off all carriers on the ASX-16, leaving a "safe" operating condition.

If the OUTCRLF command is sent to the AR-12, the terminating characters will be CARRIAGE RETURN followed by LINE FEED.

### 2-5.2. Making Cross-modulation Tests

A Cross-modulation (X-mod) test is performed using the special "X" command in both the ASX-16 and the AR-12. Note that the zeroing procedure of Section 2-5.1 should first be performed before any distortion measurements are made. For this example, module and filter number 8 has been arbitrarily selected for the distortion measurement.

For the sake of all subsequent examples, we will assume that an amplifier (the device under test) has been placed between the output of the ASX-16 and the input of the AR-12. We further assume that 35 dB of attenuation is required to bring the output of the device under test to the correct operating level.

```
160 OUTPUT 724; "A35"
170 OUTPUT 724; "X8"
180     OUTPUT 723; "X8"
190 ENTER 723 USING "#,A,6*"; R$,D3
200     IF R$="N" THEN GOTO 1100
210     REM  D3 IS THE X-MOD DISTORTION READING
1100 PRINT "INSUFFICIENT SIGNAL ON MODULE 8"
1110 STOP
```

The above program is almost identical to the procedure in Section 2-5.1; therefore the Line-by-Line explanations also apply to this example.

### -5.3. Making Composite Triple Beat Tests

A Composite triple beat (CTB) test is performed using the special "C" commands in both the ASX-16 and the AR-12. The procedure is identical to that of Section 2-5.2, except that the "X8" in line 70 is replaced by "C0", and the "X8" in line 180 is replaced by "C8".

### -5.4. Making Composite Second Order Beat Tests

A Composite Second Order beat (CSO) test can be performed on the AR-12 only if the ollowing two conditions are met:

1) one or more filters are tuned for CSO (by using an extra-wide filter, or by re-tuning a conventional filter).

2) a special CSO carrier is available (ASX-16 equipped with a special CSO carrier, or equipment contains a Frequency synthesizer).

A CSO test is performed using the special "C" commands in both the ASX-16 and the AR-12. The procedure is somewhat different to that of Section 2-5.2, because the normal ASX-16 carrier must be replaced by a special CSO carrier (using either a special ASX-16 module or an external Frequency Synthesizer. The program in Section 2-52 should be modified as follows:

The "X8" in line 170 is replaced by "C0", and the "X8" in line 180 is replaced by "C8". The following two lines must be added:

```
181   OUTPUT 724; "P8"
182   (insert appropriate instructions for CSO carrier)
183                 "
184                 "
185                 "
186                 "
187                 "
188                 "
189                 "
```

Line 181 turns off the video carrier for channel 8 (the carrier which will be replaced by the special, CSO carrier).

Lines 182 through 189 should contain whatever instructions are necessary to insert a CSO carrier at the appropriate frequency. For standard American frequencies, for example, CSO distortions are measured either 1.25 MHz above or below the video carrier. For a 550 MHz system, CSO distortions land 1.25 MHz below the video carrier for carriers below 340 MHz. CSO distortions land 1.25 MHz above the video carrier for carriers above 340 MHz. If a frequency synthesizer is used, its carrier should be adjusted to the same amplitude as that of the ASX-16 carriers.

## -5.5. Making Discrete Second Order Distortion Tests

A Discrete Second Order distortion test is performed using the special "S" commands in both ıe ASX-16 and the AR-12. Unless the ASX-16 is equipped with one or more special (offset) carriers, )iscrete Second Order distortion measurements must be made using the ASX-16 and an external 'requency Synthesizer as the carrier sources. In the following example, the Discrete Second Order istortion will be generated by channels 2, 13 and R (with the measurement being made at channel R). 'or the distortion to fall **exactly** at channel R, the channel 2 carrier frequency will have to be offset, as iven by the following formula:

$$Frequency_{2.OFFSET} = Frequency_{R} - Frequency_{13} + 15.75\ KHz$$

'he channel 2 offset frequency will be generated by the external Frequency Synthesizer. It is necessary ɔ measure the frequencies of channels 13 and R after the ASX-16 has had a chance to come up to its ormal operating temperature, in order to determine the **exact** frequency for the Synthesizer. The ynthesized frequency must be accurate to within approximately 1 to 2 KHz.

We will assume channels 13 and R have module (and filter) numbers 13 and 31, respectively. Ve will also assume, prior to the execution of line 300, that the synthesizer has already been turned on nd leveled to the same amplitude as that of the two ASX-16 carriers. As before, we assume that 35 IB of RF attenuation is necessary to bring the output of the device under test to the proper level.

```
300 OUTPUT 724; "A35"
310    OUTPUT 724; "S13,31"
320 OUTPUT 723; "S31"
330    ENTER 723 USING "#,A,6*";R$,D
340 IF R$="N" THEN GOTO 1200
350 REM  (PROGRAM CONTINUES FROM HERE)
1200 PRINT "INSUFFICIENT SIGNAL ON MODULE 31"
1210 STOP
```

Line 310 sets up the ASX-16 for a Second Order test. Channels 13 and R are set for CW ɔperation; all other ASX-16 carrier are turned off. If your ASX-16 is equipped with a special offset :arrier, the Frequency synthesizer will not be needed. Instead of the code for line 310, use the T :ommand to set up the test conditions (assume that module #1 is a special offset channel 2):

```
310    OUTPUT 724; "T1,13,31"
```

## 2-5.6. Making Discrete Third Order Distortion Tests

A Third Order distortion test is performed by using the special "T" commands in both the ASX-16 and the AR-12. Unless the ASX-16 is equipped with one or more special (offset) carriers, Third Order distortion measurements must be made using the ASX-16 and an external Frequency Synthesizer as the carrier sources. In the following example, the Third Order distortion will be generated by channels S, T, V, and W (with the measurement being made at channel V). For the distortion to fall **exactly** at channel V, the channel S carrier will have to be offset as given by the following formula:

$$Frequency_{S.OFFSET} = Frequency_{V} + Frequency_{T} - Frequency_{W} + 15.75\ KHz$$

The offset frequency will be generated by the external frequency synthesizer. In order to determine the **exact** frequency for the Synthesizer, it is necessary to measure the frequencies of channels V, T, and W, after the ASX-16 has had a chance to come up to its normal operating temperature. The synthesized frequency must be accurate to within approximately 1 to 2 KHz.

We will assume channels T, V, and W to have module (and filter) numbers 33, 35, and 36, respectively. We will also assume, prior to the execution of line 400, that the synthesizer has already turned on and leveled to the same amplitude as that of the ASX-16 carriers. As before, we assume that 35 dB of RF attenuation is necessary to bring the output of the device under test to the proper level.

```
400 OUTPUT 724; "A35"
410    OUTPUT 724; "T33,35,36"
420 OUTPUT 723; "T35"
430    ENTER 723 USING "#,A,6*";R$,D
440 IF R$="N" THEN GOTO 1300
450 REM  (PROGRAM CONTINUES FROM HERE)
1300 PRINT "INSUFFICIENT SIGNAL ON MODULE 35"
1310 STOP
```

The above program is virtually identical to that of Section 3-2.4.

If your ASX-16 is equipped with a special offset carrier, the Frequency Synthesizer will not be needed. Instead, add the following Line to your program (assume that module #32 is a special offset channel S):

```
415    OUTPUT 724; "C32"
```

### 2-5.7. Adjusting the Output Levels of the ASX-16

The first step in leveling the ASX-16's output is to measure the amplitude of a "typical" carrier near the middle of the ASX-16's frequency spectrum. The RF attenuators are then adjusted (using the ASX-16's A or V commands) to bring the carrier level of this "typical" carrier to within one dB of the desired level. The final "fine-tuning" of carrier amplitudes is performed using the ASX-16's "L" command. This allows the individual modules to be leveled or sloped exactly as required by a particular application.

To perform the leveling, an external power meter, or spectrum analyzer, or similar device, must be used. In order to cover all possible power-measuring devices, a procedure, rather than a complete program, is provided:

1) Set up the ASX-16's RF attenuators as described in the first paragraph of Section 2-5.7.

2) Turn off all ASX-16 carriers using the command:

   ```
   400 OUTPUT 724; "P0"
   ```

3) Set the variable M to the module number of the module which is to be turned on, then turn on this module, using the command:

   ```
   500 OUTPUT 724; "C"; M
   ```

4) Measure the output level of the module to see if it is close enough. If the Level is acceptable, skip to Step 6). If the level is not acceptable, generate an "error" value E by using the following formula (E is the error; R is the power meter reading; D is the desired power meter reading):

```
510    E = R - D
```

Convert E to **tenths** of a dB by multiplying the error by 10:

```
520    E = 10 * E
```

Note: some modules may produce steps greater than .1 dB. If you run into this problem, multiply by 5 instead of 10 in line 520.

5) Correct the level of module #M (and read the ASX-16's response) by using the following commands:

```
600    OUTPUT 724; "L"; M; ","; E
610    ENTER 724 USING "#,A"; R$
620 IF R$="N" THEN GOTO 2000
```

Lines 2000 through 2020 handle modules which have run out of adjustment range:

```
2000 PRINT "ERROR"
2010 PRINT "MODULE NUMBER "; M; " IS AT ITS LIMIT"
2020 STOP
```

6) When the amplitude of this module is correct, repeat Steps 2) through 5) for each of the remaining modules. If the carrier levels are to be sloped, the value of D, in Step 4) will change for each module. If the measured level oscillates by first being too great, then being to small (and so forth), see the Note in Step 4.

## 2-5.8. Performing Tests Without Using All Carriers

It is often desirable to make distortion measurements using a limited number of carriers. For example, the ASX-16 might be outfitted with seventy-six channels, but the desired X-mod test is to be performed using only channels 2 through W. The carriers below channel 2 (module number 8, in this example) and those above W (module 42) must be turned off. This can be performed using the following modification to the program of Section 2-5.2. In this example, the undesired carriers are generated by modules 1 through 7 and modules 43 through 76.

```
160 OUTPUT 724; "A35"
170 OUTPUT 724; "X8"
171 FOR I=1 TO 7
172   OUTPUT 724; "P"; I
173 NEXT I
174 FOR I=43 TO 76
175   OUTPUT 724; "P"; I
176 NEXT I
180     OUTPUT 723; "X8"
190 ENTER 723 USING "#,A,6*"; R$,D
  (ETC.)
        .
        .
        .
```

Line 170 turns on all modules 100% modulated, except for module #8, which is turned on CW.

Lines 171 through 173 and lines 174 through 176 turn off the two groups of undesired carriers.

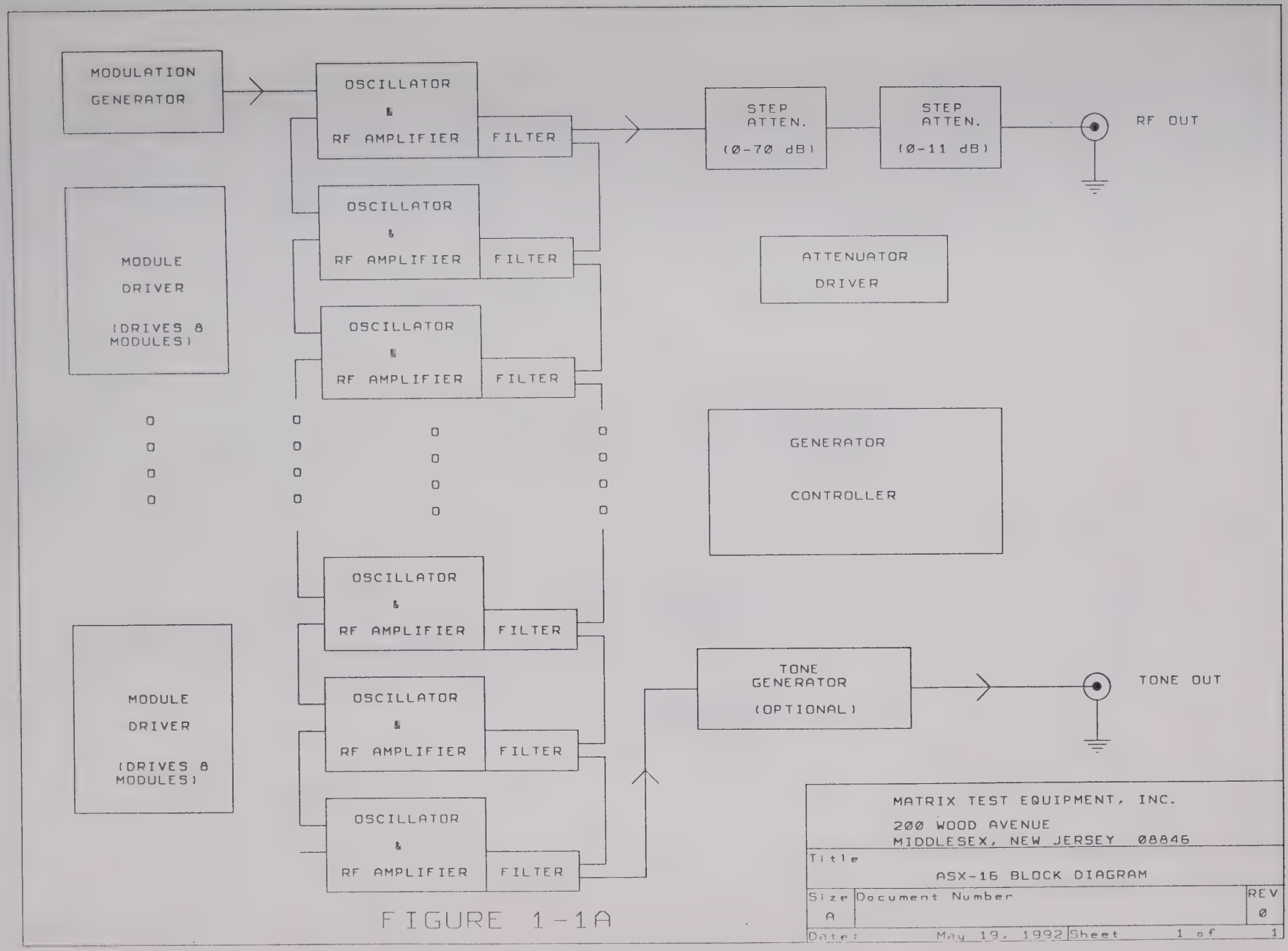

MODULATION GENERATOR
OSCILLATOR & RF AMPLIFIER
FILTER
STEP ATTEN. (0-70 dB)
STEP ATTEN. (0-11 dB)
RF OUT
MODULE DRIVER (DRIVES 8 MODULES)
ATTENUATOR DRIVER
GENERATOR CONTROLLER
TONE GENERATOR (OPTIONAL)
TONE OUT
MATRIX TEST EQUIPMENT, INC.
200 WOOD AVENUE
MIDDLESEX, NEW JERSEY 08846
Title
ASX-16 BLOCK DIAGRAM
Size A
Document Number
REV 0
Date: May 19, 1992
Sheet 1 of 1

FIGURE 1-1A

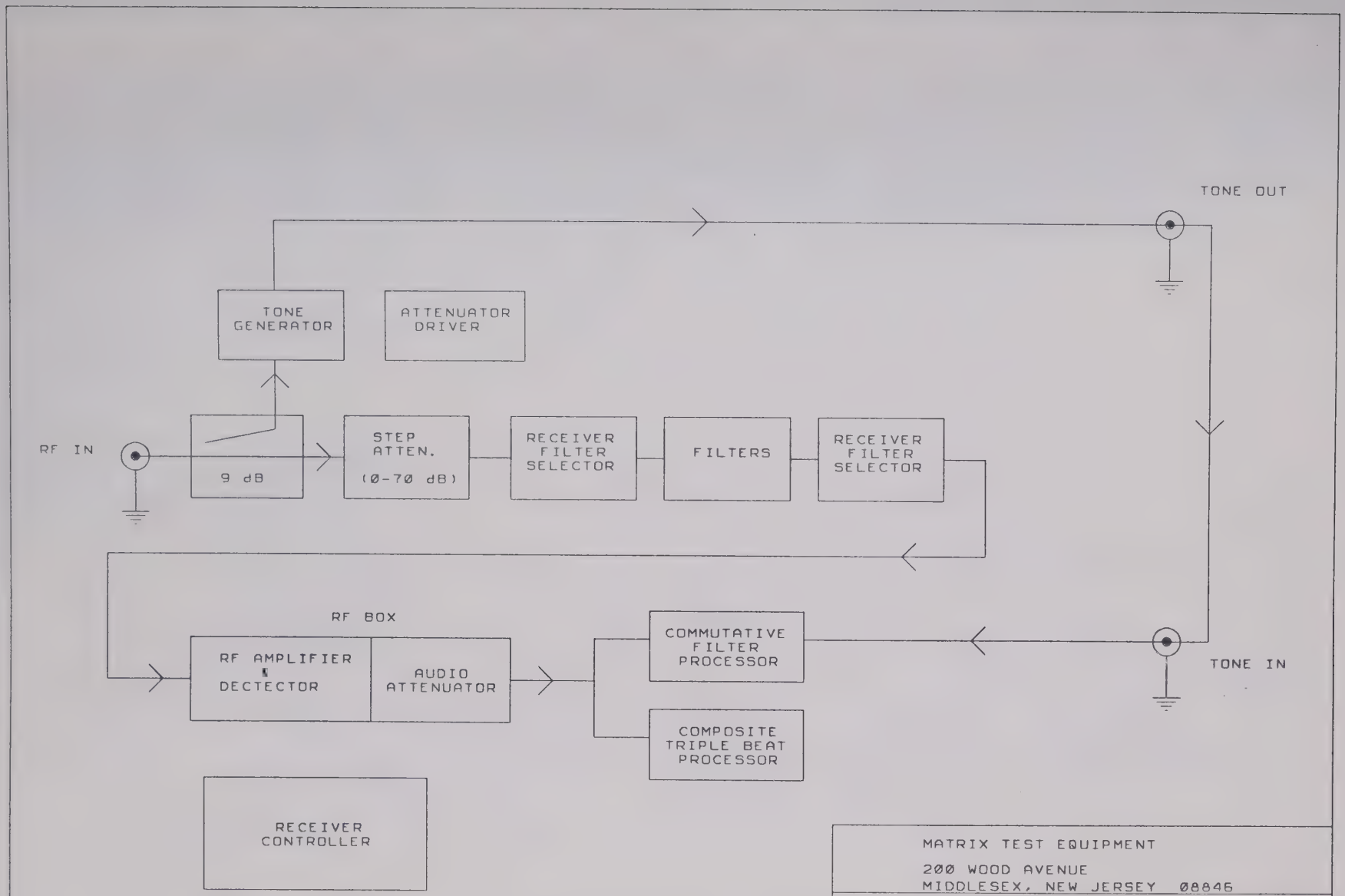



FIGURE 1-1B

| | | |
|---|---|---|
| MATRIX TEST EQUIPMENT<br>200 WOOD AVENUE<br>MIDDLESEX, NEW JERSEY 08846 | | |
| Title: AR-12 BLOCK DIAGRAM | | |
| Size: A | Document Number | REV: 0 |
| Date: May 19, 1992 | Sheet 1 of | |

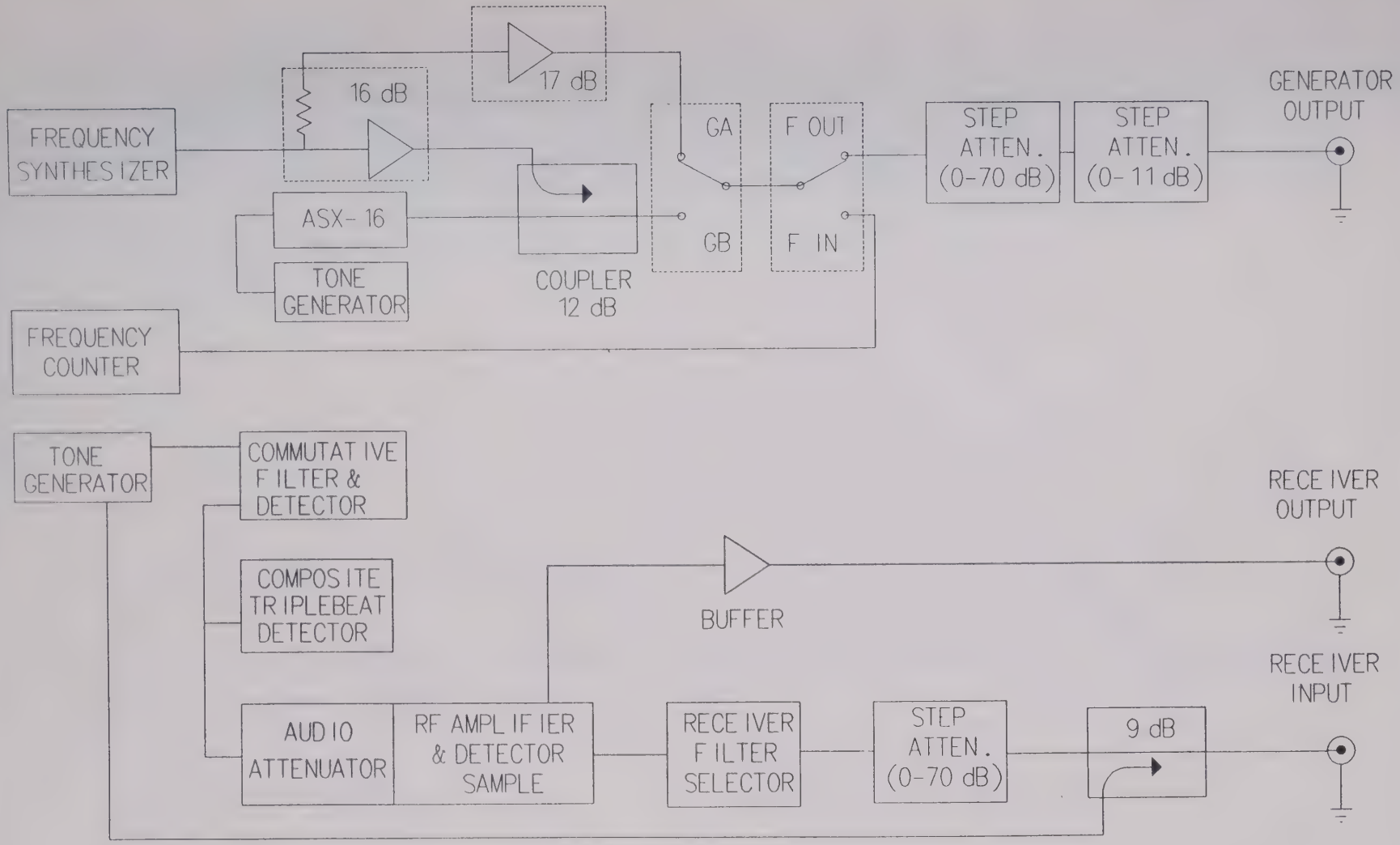

FREQUENCY SYNTHESIZER
16 dB
17 dB
ASX-16
TONE GENERATOR
COUPLER 12 dB
GA
GB
F OUT
F IN
STEP ATTEN. (0-70 dB)
STEP ATTEN. (0-11 dB)
GENERATOR OUTPUT
FREQUENCY COUNTER
TONE GENERATOR
COMMUTATIVE FILTER & DETECTOR
COMPOSITE TRIPLEBEAT DETECTOR
AUDIO ATTENUATOR
RF AMPLIFIER & DETECTOR SAMPLE
BUFFER
RECEIVER FILTER SELECTOR
STEP ATTEN. (0-70 dB)
9 dB
RECEIVER OUTPUT
RECEIVER INPUT

FIGURE 1-1C

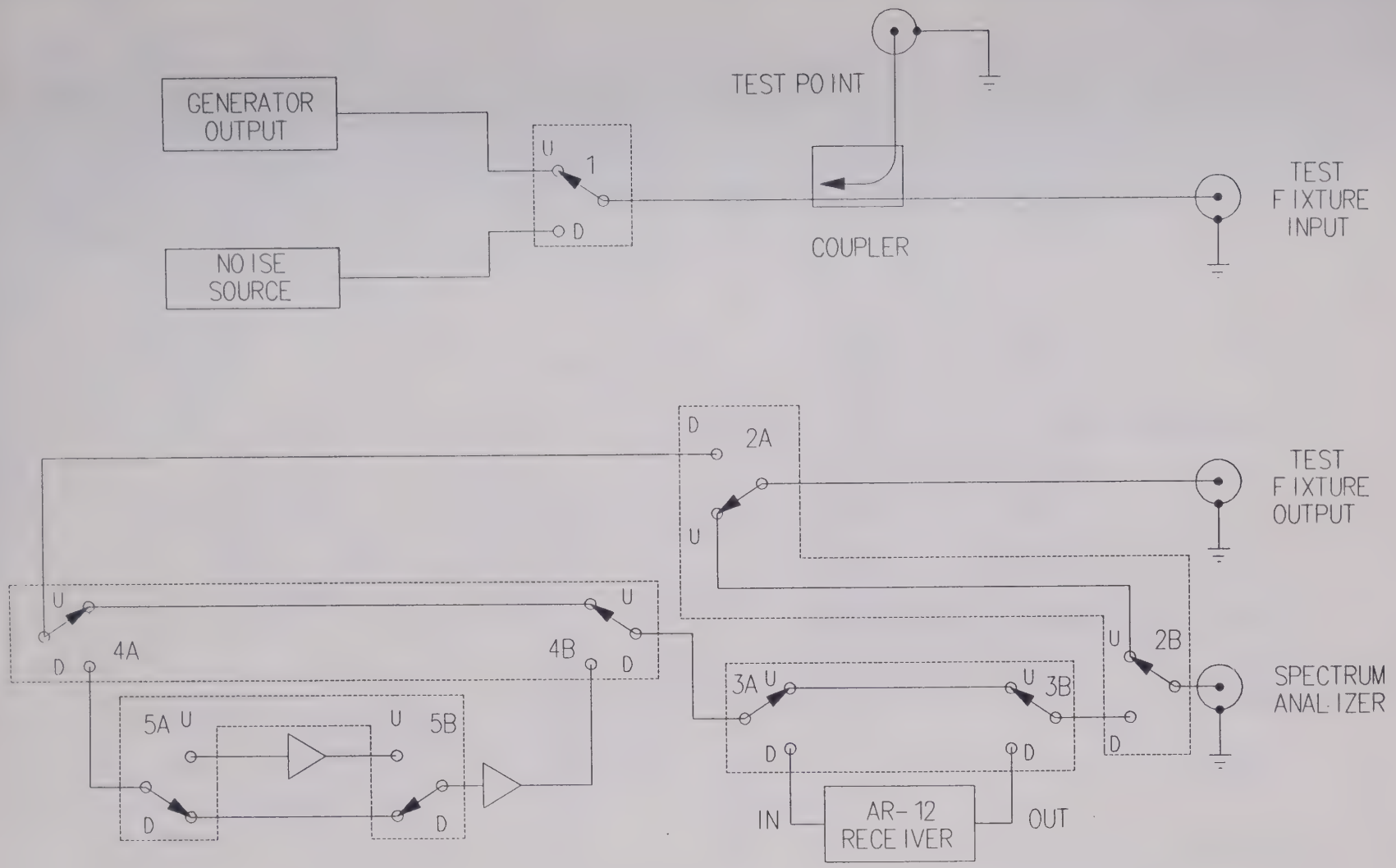



FIGURE 1 - 2

AUG

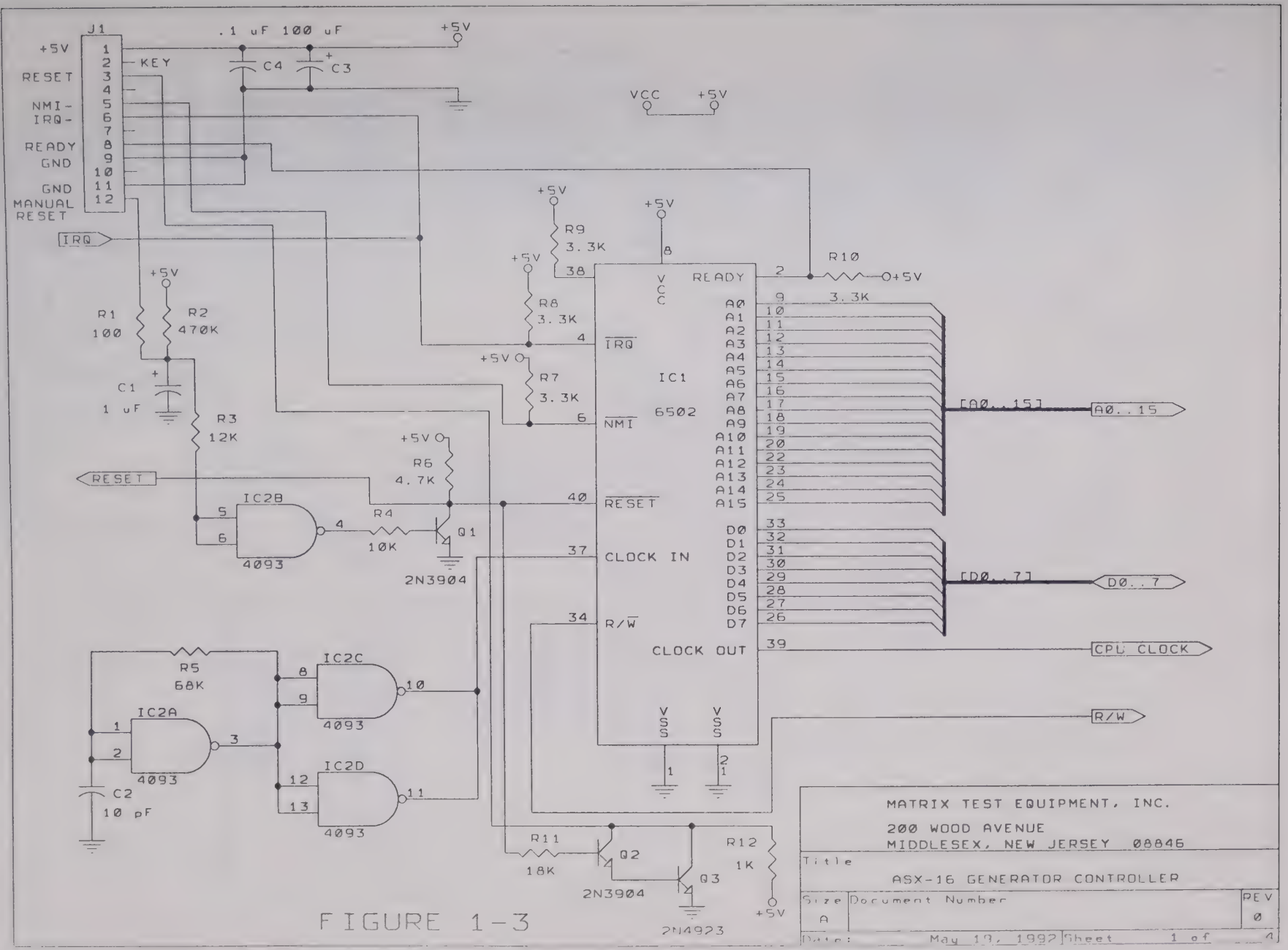



FIGURE 1-3

MATRIX TEST EQUIPMENT, INC.
200 WOOD AVENUE
MIDDLESEX, NEW JERSEY 08846

Title: ASX-16 GENERATOR CONTROLLER

Size: A | Document Number | REV: 0

Date: May 10, 1992 | Sheet 1 of 4

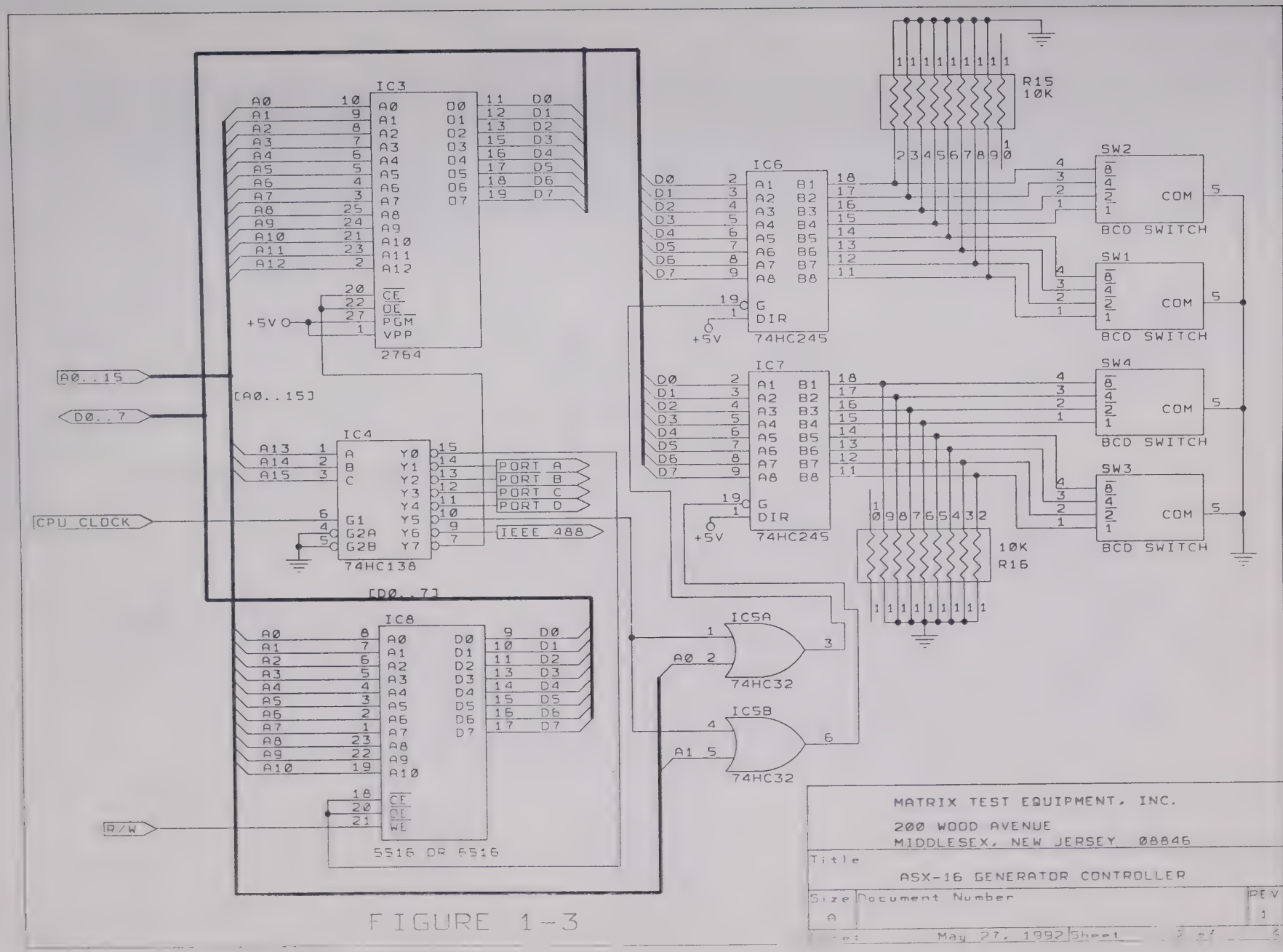

IC3
2764
IC4
74HC138
IC5A
74HC32
IC5B
74HC32
IC6
74HC245
IC7
74HC245
IC8
5516 OR 6516
R15
10K
R16
10K
SW1
SW2
SW3
SW4
BCD SWITCH
COM
A0..15
[A0..15]
D0..7
[D0..7]
CPU CLOCK
R/W
+5V
PORT A
PORT B
PORT C
PORT D
IEEE 488
MATRIX TEST EQUIPMENT, INC.
200 WOOD AVENUE
MIDDLESEX, NEW JERSEY 08846
Title
ASX-16 GENERATOR CONTROLLER
Size
A
Document Number
REV
1
Date: May 27, 1992
Sheet

FIGURE 1-3

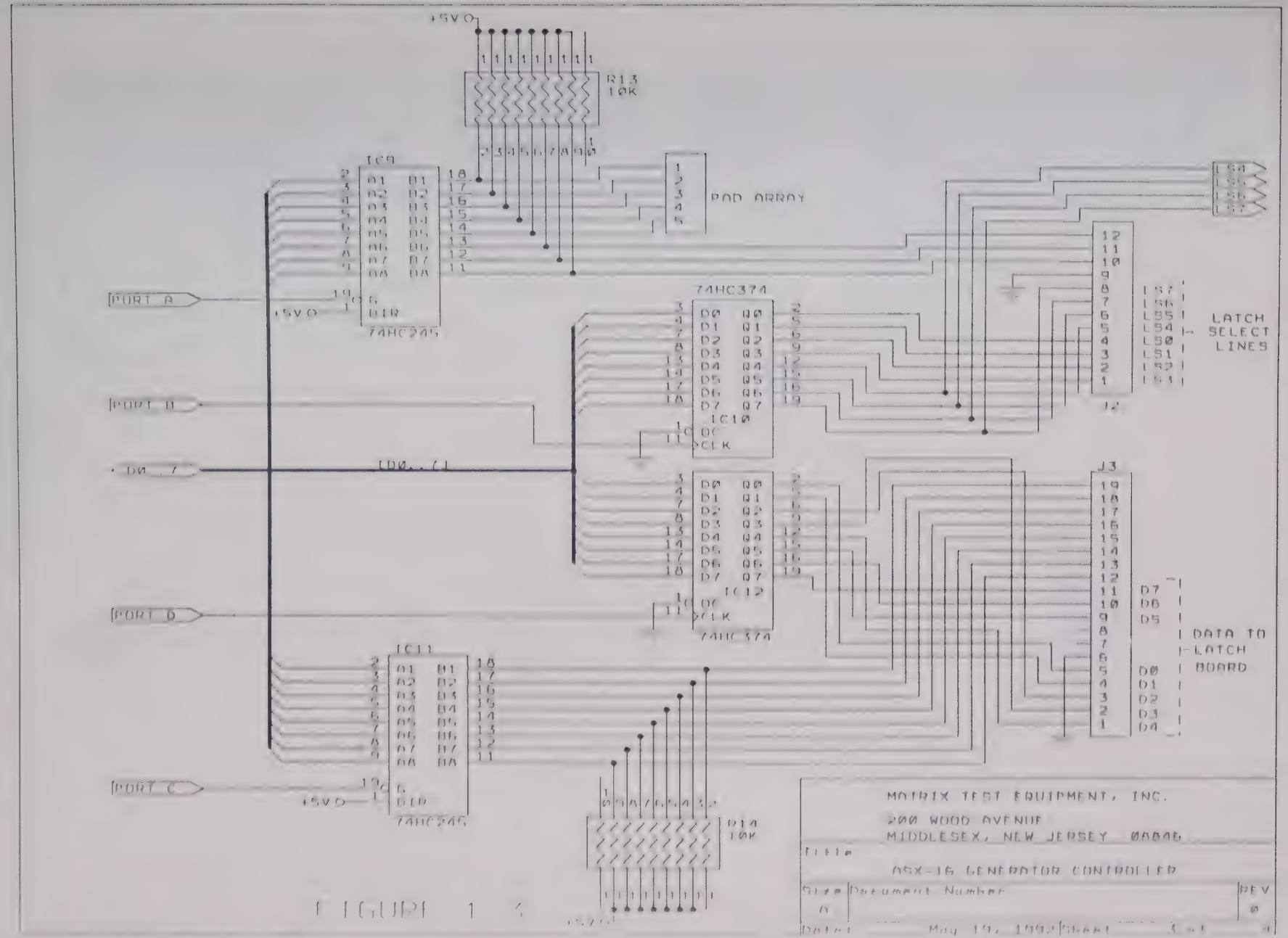
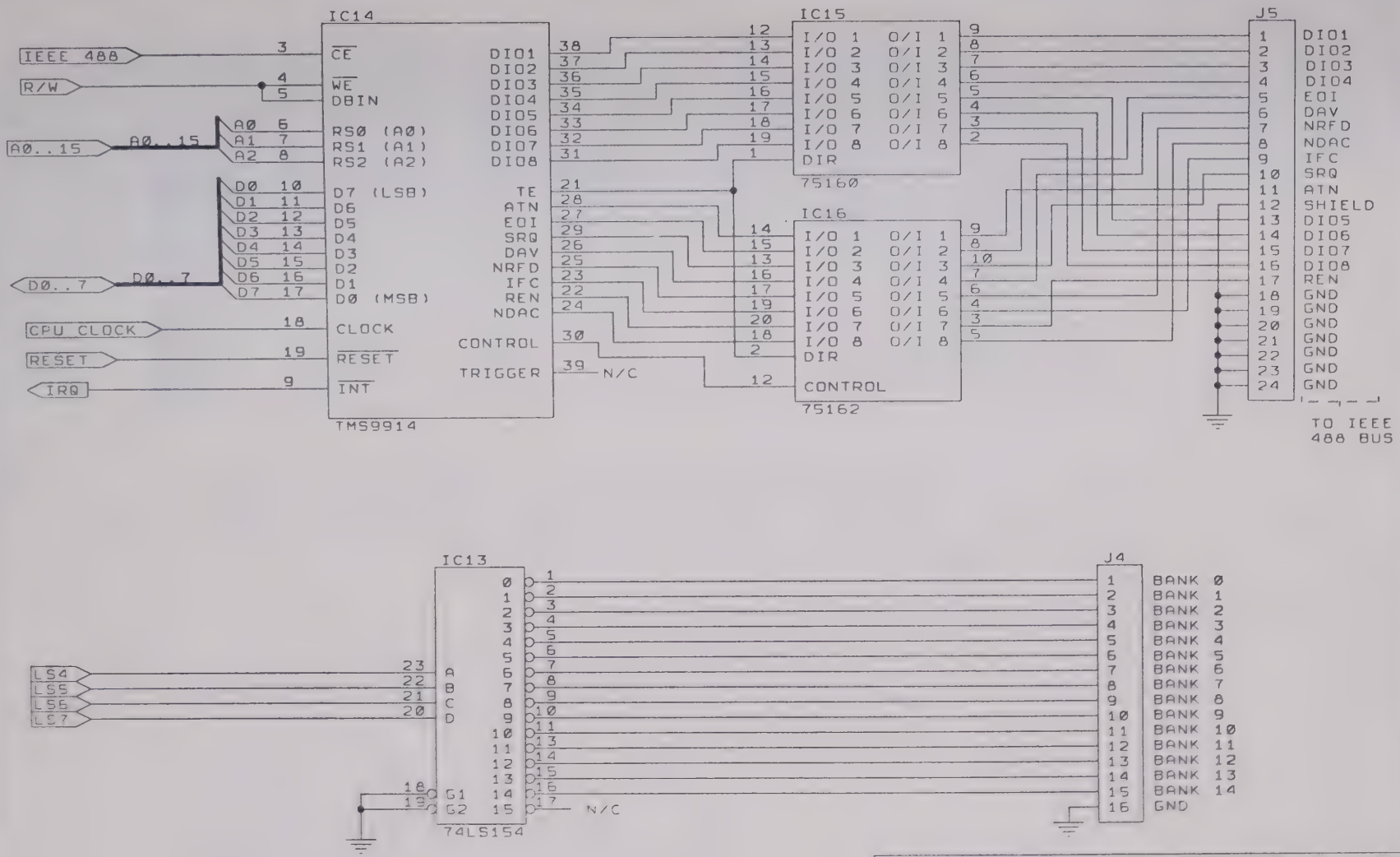

+5VD
R13
10K
IC9
74HC245
POD ARRAY
PORT A
PORT B
D0..7
PORT D
PORT C
74HC374
IC10
IC12
IC11
LATCH
SELECT
LINES
J3
DATA TO
LATCH
BOARD
R14
10K
MATRIX TEST EQUIPMENT, INC.
200 WOOD AVENUE
MIDDLESEX, NEW JERSEY 08846
Title
GSX-16 GENERATOR CONTROLLER
Size
B
Document Number
REV
0
Date: May 19, 1992
Sheet

FIGURE 1.4




MATRIX TEST EQUIPMENT, INC.

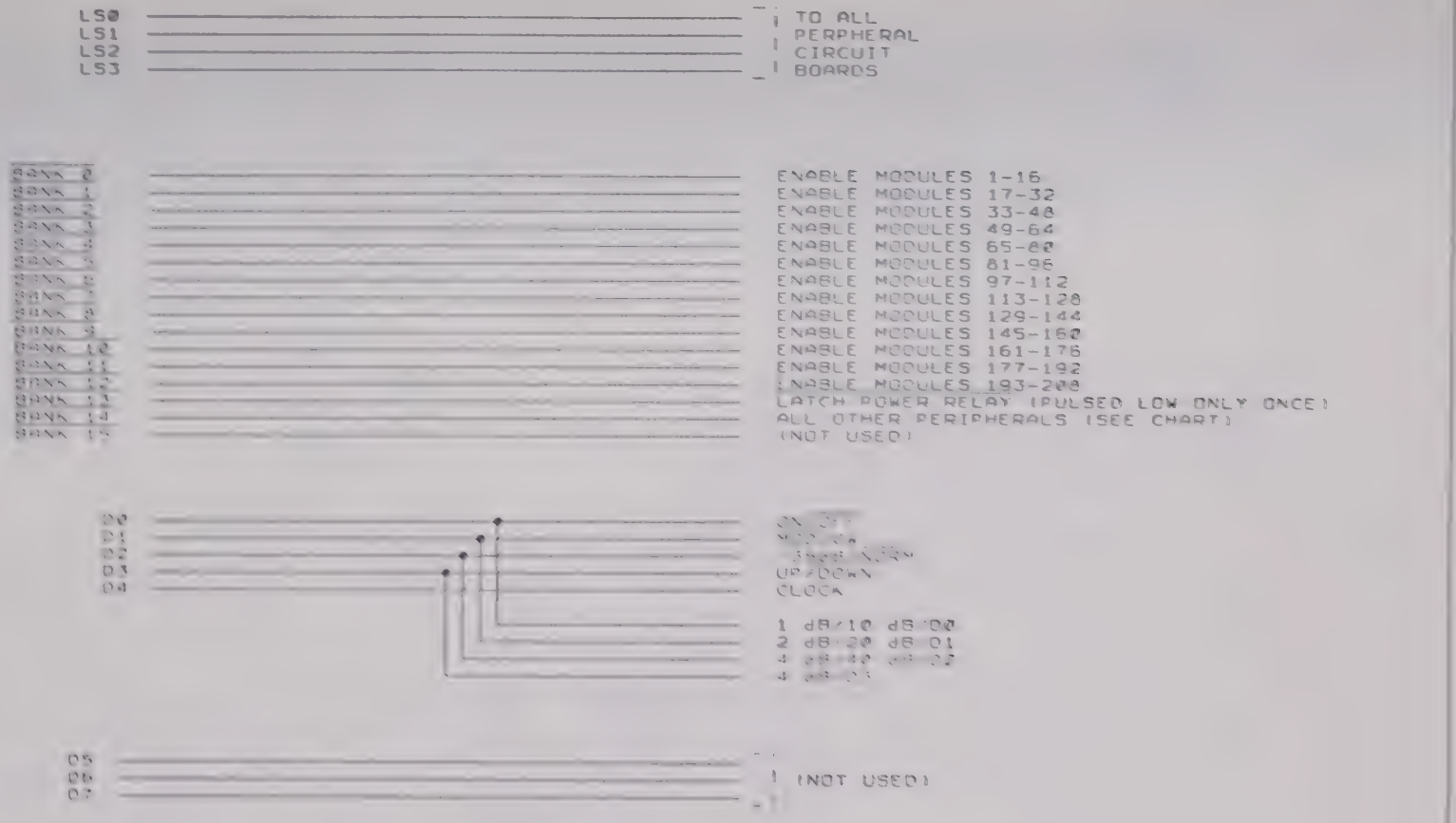
200 WOOD AVENUE
MIDDLESEX, NEW JERSEY 08846

Title

ASX-15 GENERATOR CONTROLLER

Size | Document Number | REV

FIGURE 1-3




| BANK 14 | LS3 | LS2 | LS1 | LS0 | PERIPHERAL |
|---|---|---|---|---|---|
| 0 | 0 | 0 | 0 | 0 | SELECTS 1-4 |
| 0 | 0 | 0 | 0 | 1 | SELECTS 5-8 |
| 0 | 0 | 0 | 1 | 0 | SELECTS 9-10 |
| 0 | 0 | 0 | 1 | 1 | I/O SELECT |
| 0 | 0 | 1 | 0 | 0 | MISC. CONTROL |
| 0 | 0 | 1 | 0 | 1 | 0.5 DB ATTEN. |
| 0 | 0 | 1 | 1 | 0 | 0.11 DB ATTEN. |
| 0 | 0 | 1 | 1 | 1 | 0.70 DB ATTEN. |

FIGURE 1-4

| | | |
|---|---|---|
| MATRIX TEST EQUIPMENT<br>300 WOOD AVENUE<br>MIDDLESEX, NEW JERSEY 08846 | | |
| Title: ASX-16 EXTERNAL SIGNALS | | |
| Size: A | Document Number: | REV: 0 |
| Date: May 20, 1992 | Sheet 1 of 1 | |

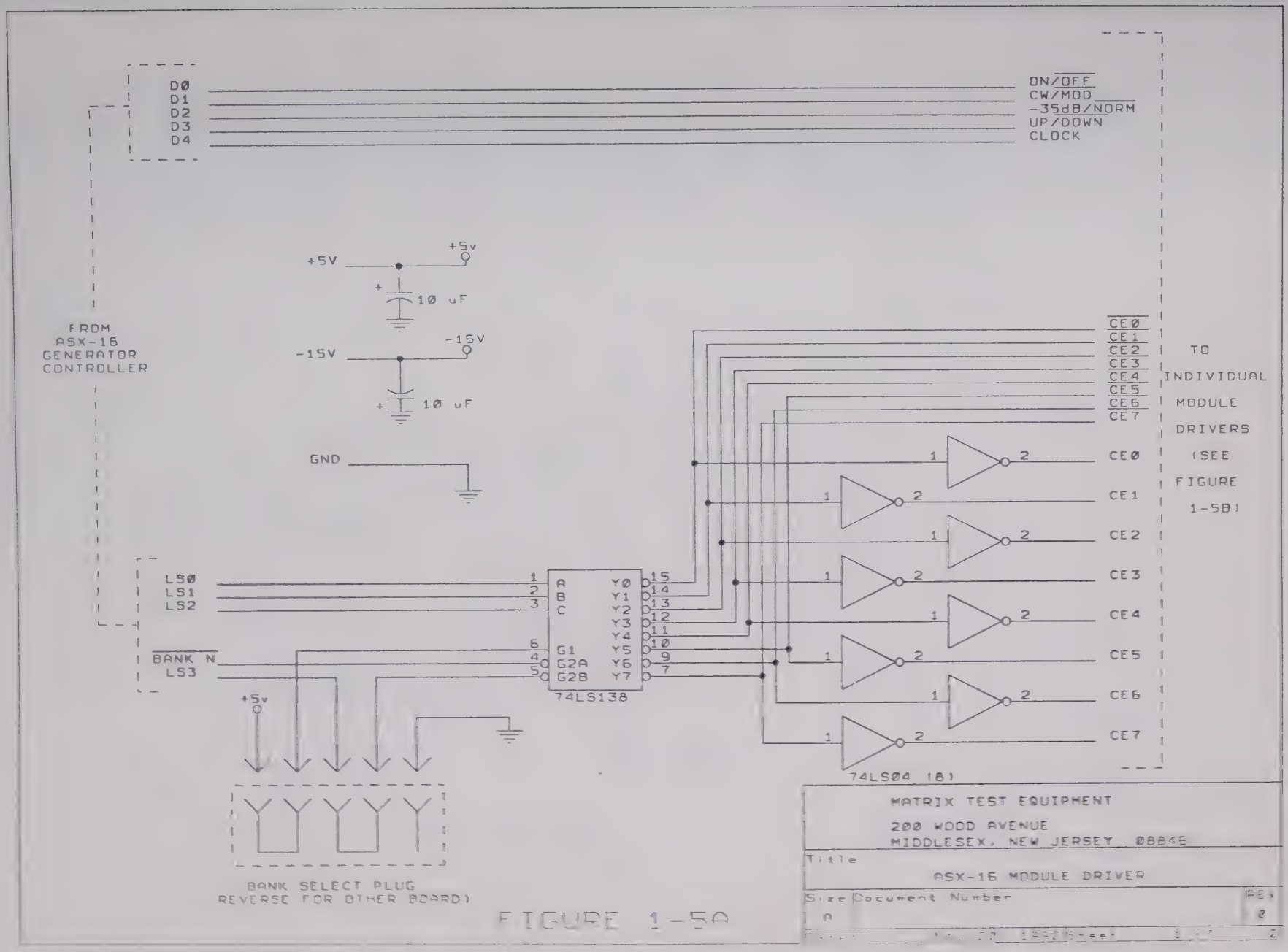

D0
D1
D2
D3
D4
ON/OFF
CW/MOD
-35dB/NORM
UP/DOWN
CLOCK
FROM ASX-16 GENERATOR CONTROLLER
+5V
+5v
10 uF
-15V
-15v
10 uF
GND
LS0
LS1
LS2
BANK N
LS3
A
B
C
G1
G2A
G2B
Y0
Y1
Y2
Y3
Y4
Y5
Y6
Y7
74LS138
74LS04 (8)
CE0
CE1
CE2
CE3
CE4
CE5
CE6
CE7
TO INDIVIDUAL MODULE DRIVERS (SEE FIGURE 1-5B)
BANK SELECT PLUG
REVERSE FOR OTHER BOARD)
MATRIX TEST EQUIPMENT
200 WOOD AVENUE
MIDDLESEX, NEW JERSEY 08846
Title
ASX-15 MODULE DRIVER
Size
Document Number
A

FIGURE 1-5A

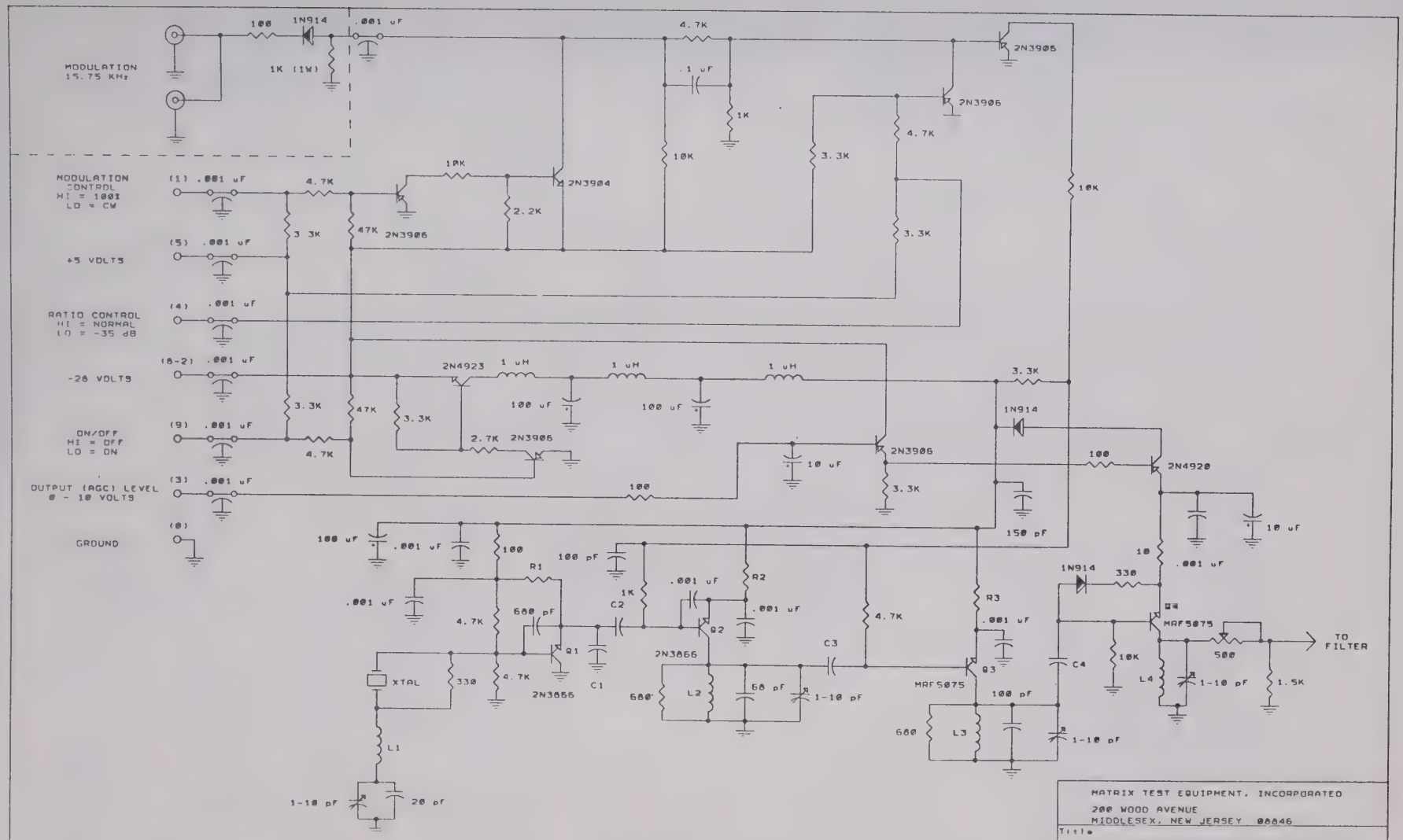

MODULATION 15.75 KHz
100
1N914
1K (1W)
.001 uF
4.7K
.1 uF
1K
2N3905
2N3906
10K
3.3K
4.7K
MODULATION CONTROL HI = 100% LO = CW
(1) .001 uF
10K
2N3904
2.2K
4.7K
3.3K
47K
2N3906
+5 VOLTS
(5) .001 uF
RATIO CONTROL HI = NORMAL LO = -35 dB
(4) .001 uF
(6-2) .001 uF
-28 VOLTS
2N4923
1 uH
100 uF
ON/OFF HI = OFF LO = ON
(9) .001 uF
2.7K
OUTPUT (AGC) LEVEL 0 - 10 VOLTS
(3) .001 uF
(8)
GROUND
1N914
2N4920
10 uF
150 pF
100 uF
R1
R2
R3
C1
C2
C3
C4
100 pF
680 pF
Q1
Q2
Q3
2N3866
MRF5075
XTAL
330
L1
L2
L3
L4
68 pF
1-10 pF
20 pF
500
1.5K
TO FILTER
MATRIX TEST EQUIPMENT, INCORPORATED
200 WOOD AVENUE
MIDDLESEX, NEW JERSEY 08846
Title
ASX-16 GENERATOR MODULE (LOW FREQUENCY)
Size
A
Document Number
REV
1
Date: May 20, 1992
Sheet
of

FIGURE 1-6

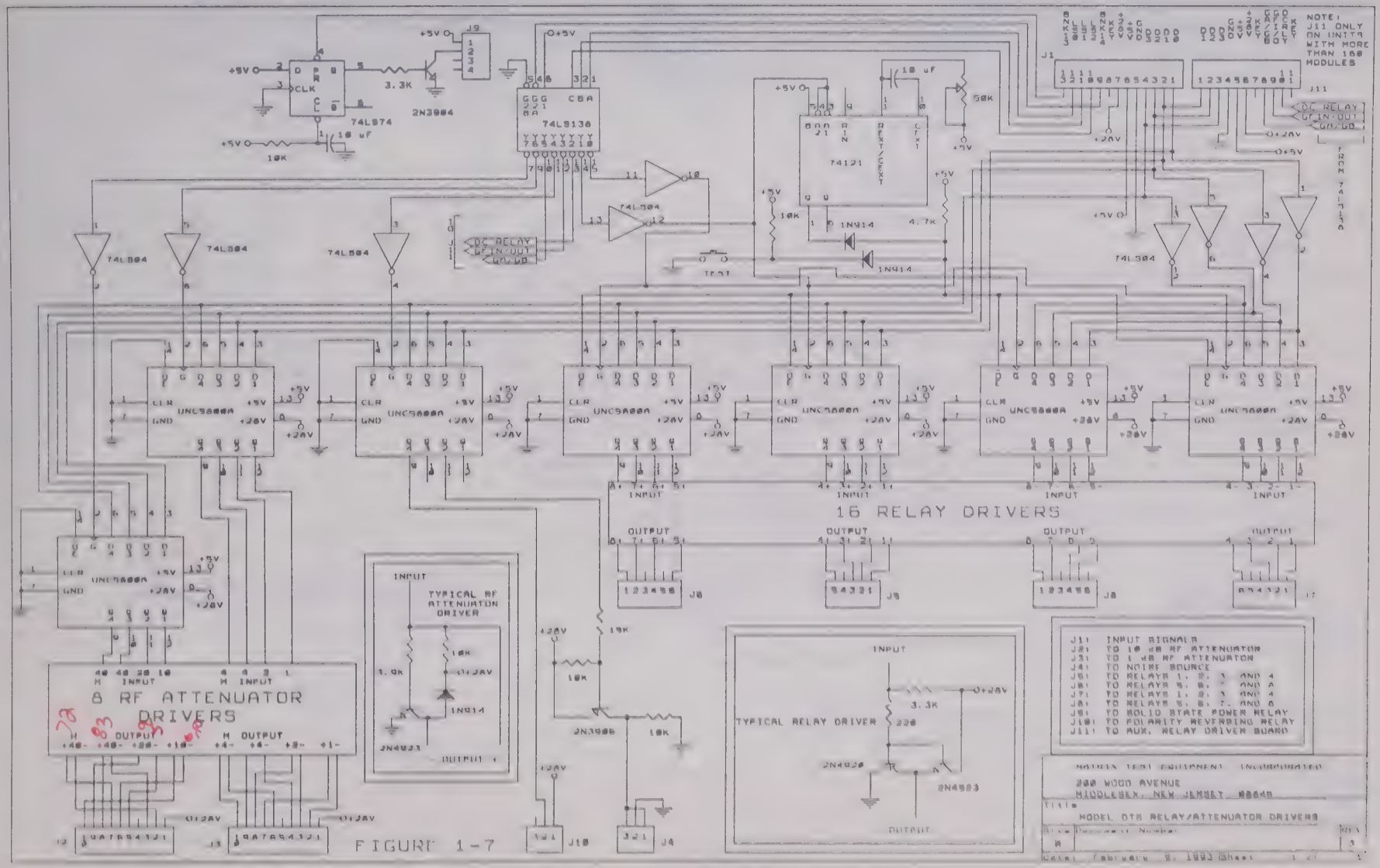

16 RELAY DRIVERS
8 RF ATTENUATOR DRIVERS
TYPICAL RF ATTENUATOR DRIVER
TYPICAL RELAY DRIVER
74LS374
74LS138
74121
74LS04
UNC5800A
2N3904
2N4923
1N914
NOTE: J11 ONLY ON UNITS WITH MORE THAN 16 MODULES
J1: INPUT SIGNALS
J2: TO 10 dB RF ATTENUATOR
J3: TO 1 dB RF ATTENUATOR
J4: TO NOISE SOURCE
J5: TO RELAYS 1, 2, 3 AND 4
J6: TO RELAYS 5, 6, 7 AND 8
J7: TO RELAYS 1, 2, 3 AND 4
J8: TO RELAYS 5, 6, 7, AND 8
J9: TO SOLID STATE POWER RELAY
J10: TO POLARITY REVERSING RELAY
J11: TO AUX. RELAY DRIVER BOARD
200 WOOD AVENUE
MIDDLESEX, NEW JERSEY 08846
MODEL DTR RELAY/ATTENUATOR DRIVERS

FIGURE 1-7

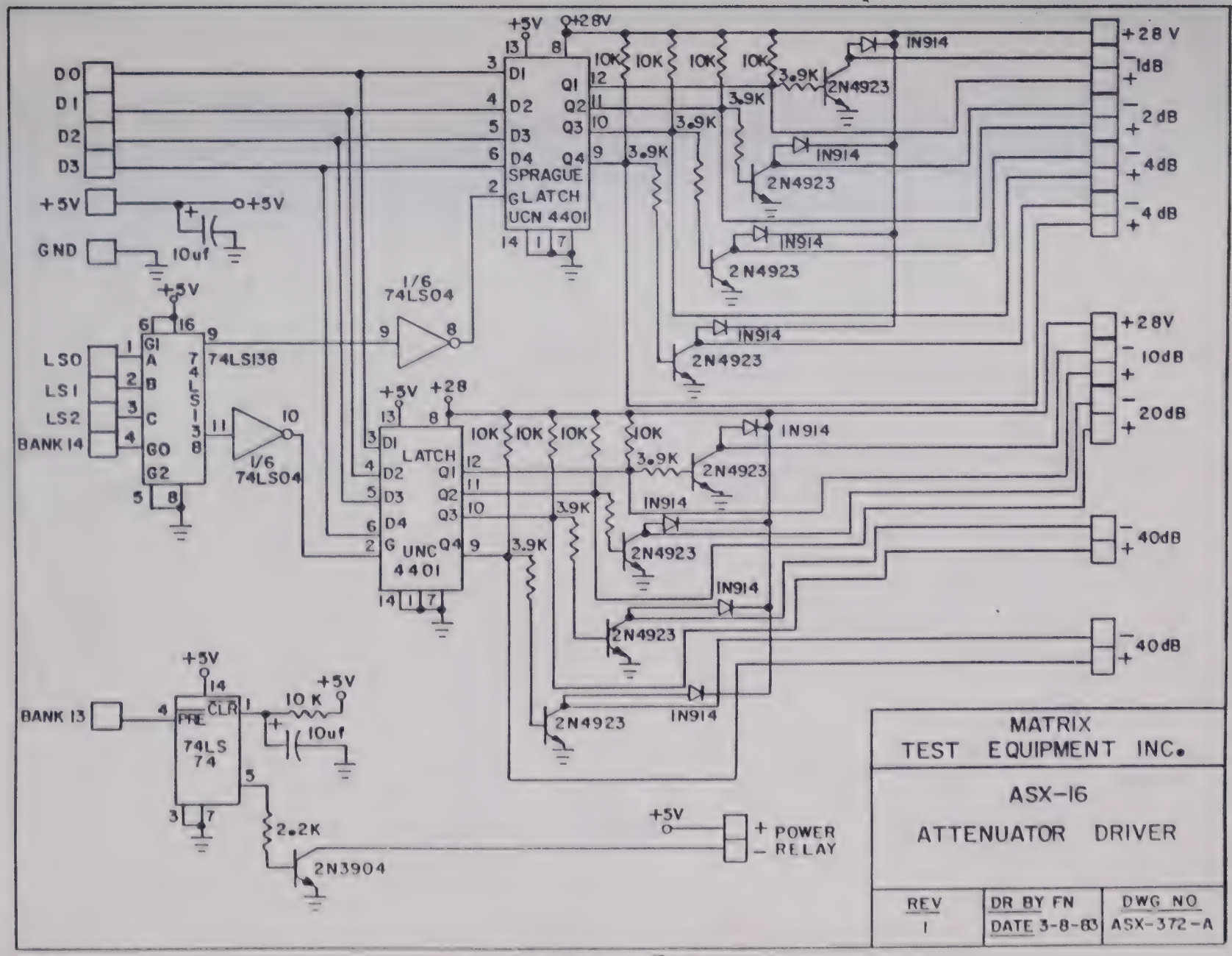

D0
D1
D2
D3
+5V
GND
10uf
+5V
+28V
SPRAGUE
GLATCH
UCN 4401
DI
D2
D3
D4
Q1
Q2
Q3
Q4
10K
3.9K
2N4923
IN914
+28 V
1dB
2dB
4dB
4 dB
1/6
74LS04
74LS138
LS0
LS1
LS2
BANK 14
LATCH
UNC
4401
+28
10dB
20dB
40dB
40dB
BANK 13
74LS
74
PRE
CLR
10 K
2.2K
2N3904
+ POWER
- RELAY
MATRIX
TEST EQUIPMENT INC.
ASX-16
ATTENUATOR DRIVER
REV
1
DR BY FN
DATE 3-8-83
DWG NO
ASX-372-A

FIGURE 1-7

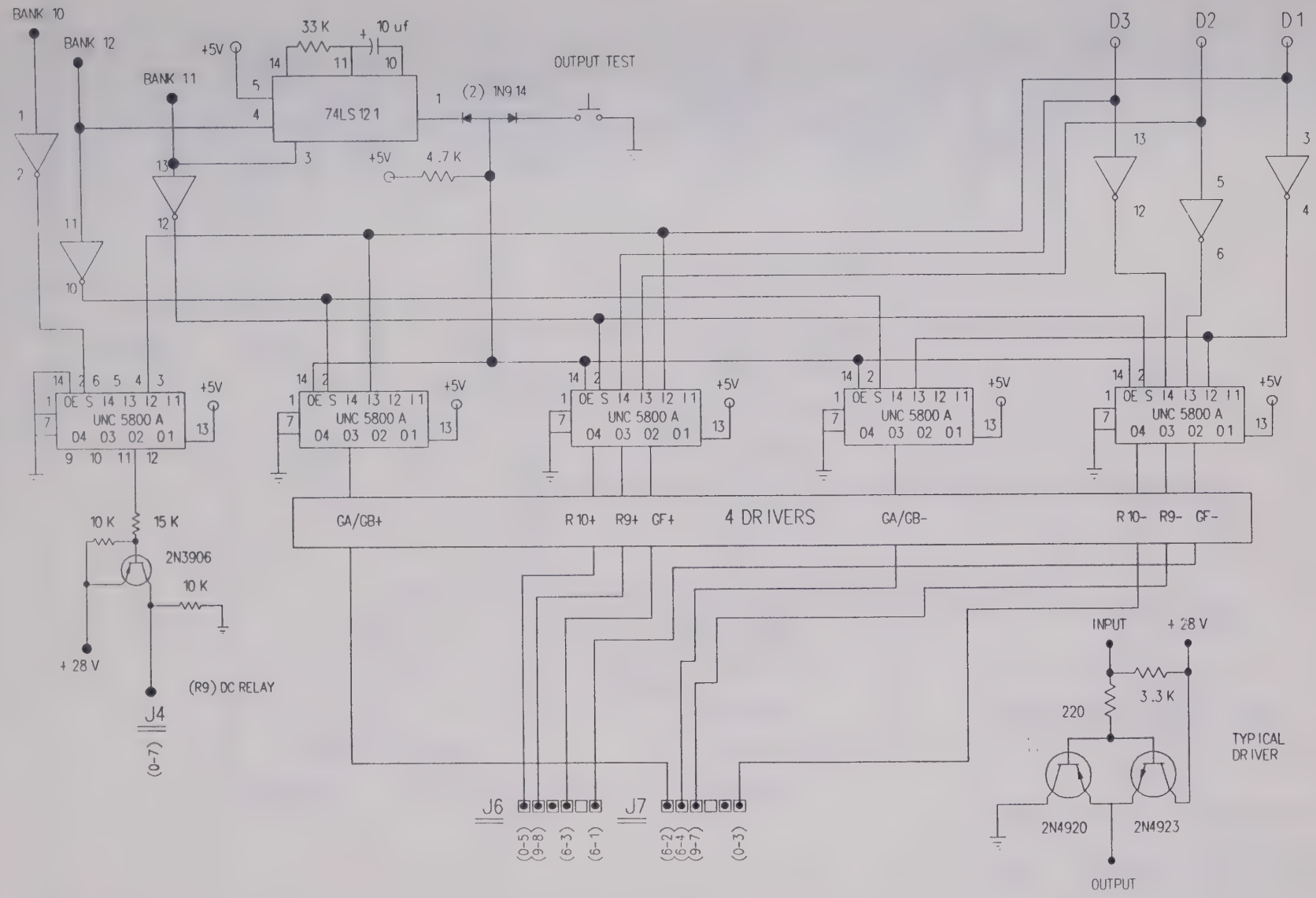

BANK 10
BANK 12
BANK 11
+5V
33 K
10 uf
74LS 121
OUTPUT TEST
(2) 1N9 14
+5V
4.7 K
D3
D2
D1
UNC 5800 A
04 03 02 01
+5V
GA/GB+
R 10+ R9+ GF+
4 DRIVERS
GA/GB-
R 10- R9- GF-
10 K
15 K
2N3906
10 K
+ 28 V
(R9) DC RELAY
J4
(0-7)
J6
J7
(0-5)
(9-8)
(6-3)
(6-1)
(6-2)
(6-4)
(9-7)
(0-3)
INPUT
+ 28 V
3.3 K
220
2N4920
2N4923
OUTPUT
TYPICAL
DRIVER

FIGURE 1-8

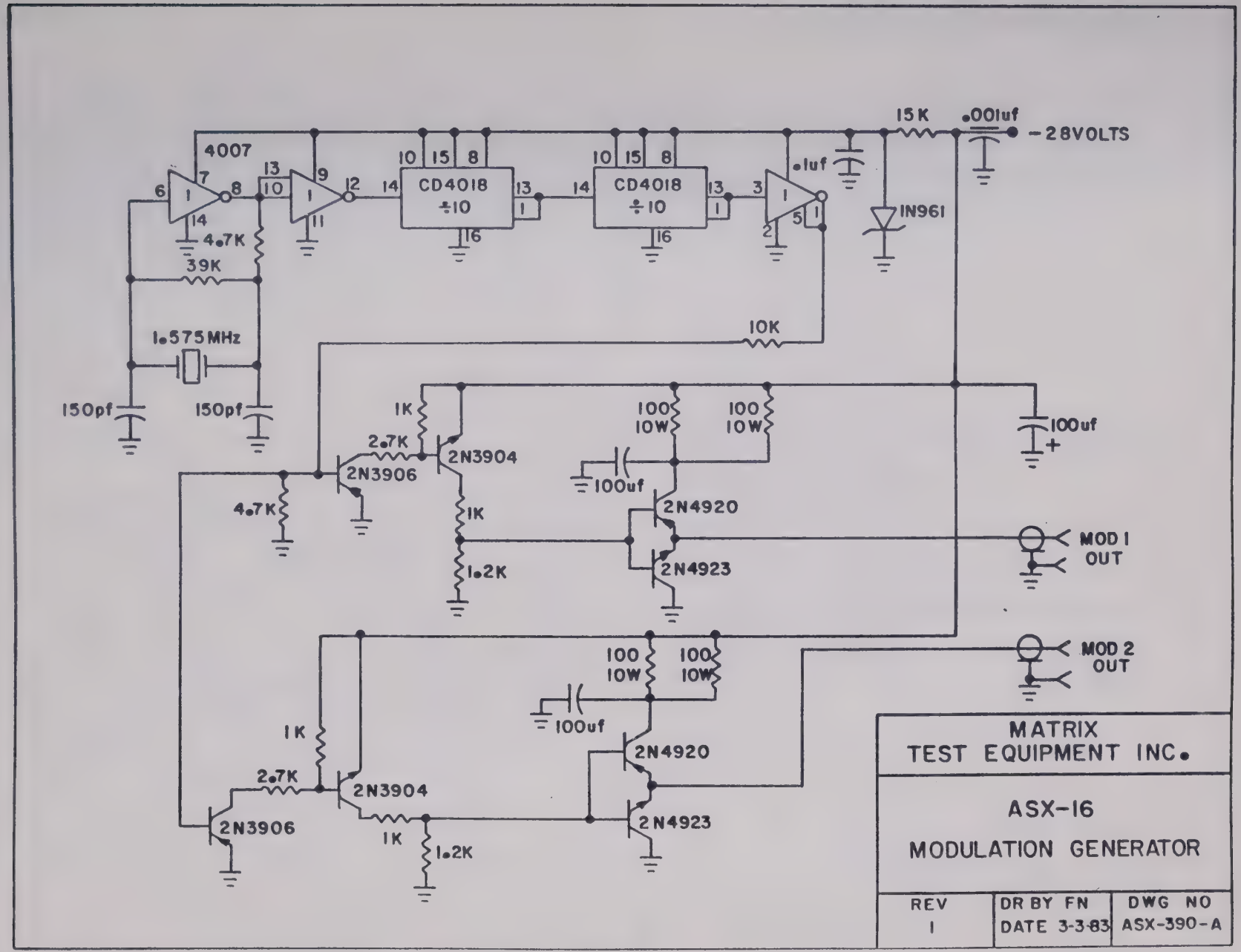

4007
CD4018 ÷10
CD4018 ÷10
15K
.001uf
-28VOLTS
.1uf
IN961
4.7K
39K
1.575MHz
150pf
150pf
10K
1K
2.7K
2N3904
2N3906
4.7K
1K
1.2K
100 10W
100 10W
100uf
100uf
2N4920
2N4923
MOD 1 OUT
MOD 2 OUT
MATRIX TEST EQUIPMENT INC.
ASX-16
MODULATION GENERATOR
REV 1
DR BY FN
DATE 3-3-83
DWG NO ASX-390-A

FIGURE 1-9

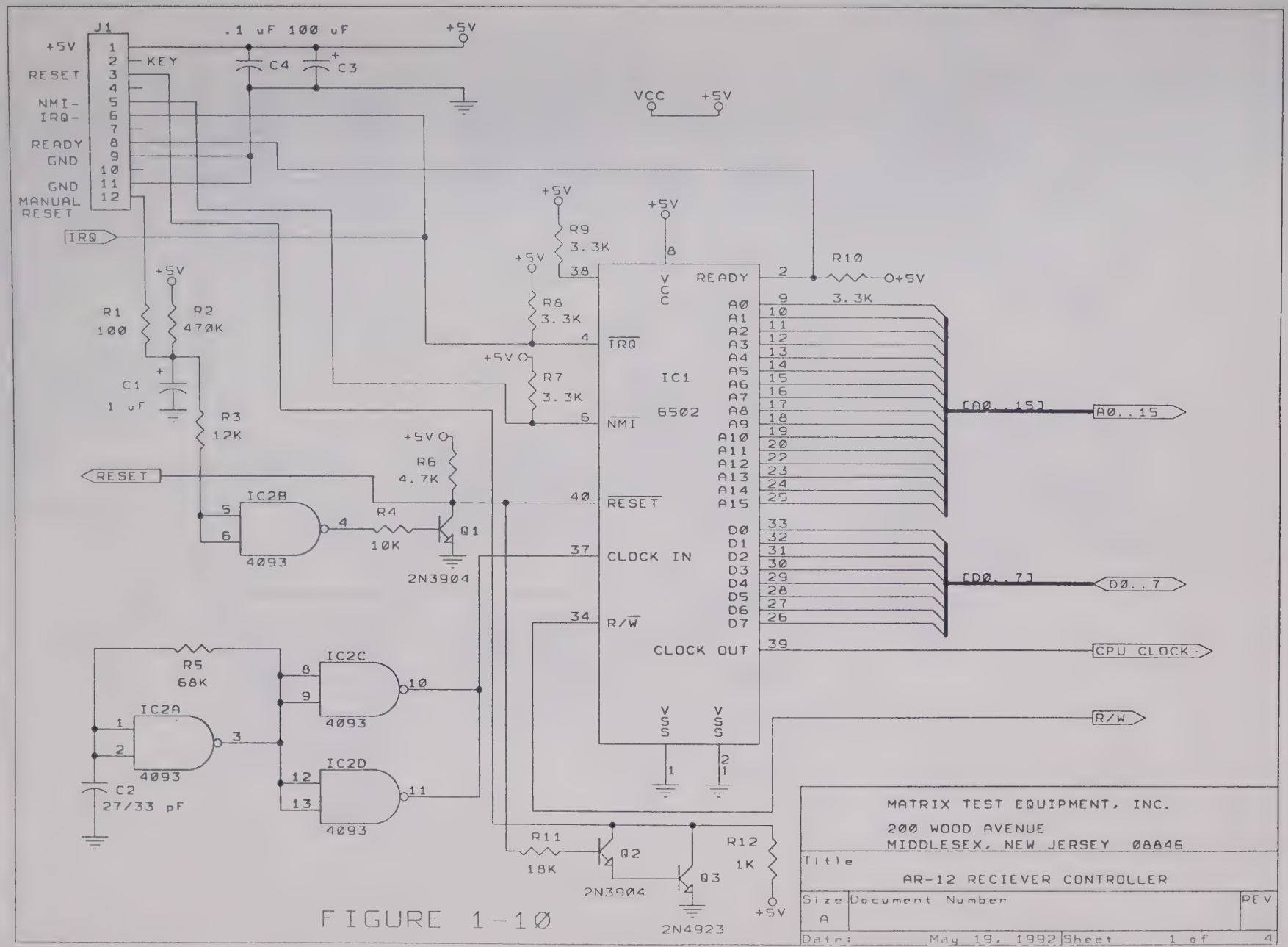

J1
+5V
RESET
NMI-
IRQ-
READY
GND
GND
MANUAL RESET
KEY
.1 uF
100 uF
C4
C3
VCC
IRQ
R1
100
R2
470K
C1
1 uF
R3
12K
R9
3.3K
R8
3.3K
R7
3.3K
R6
4.7K
R10
3.3K
IC1
6502
READY
IRQ
NMI
RESET
CLOCK IN
R/W
CLOCK OUT
A0
A1
A2
A3
A4
A5
A6
A7
A8
A9
A10
A11
A12
A13
A14
A15
D0
D1
D2
D3
D4
D5
D6
D7
[A0..15]
A0..15
[D0..7]
D0..7
CPU CLOCK
IC2B
4093
R4
10K
Q1
2N3904
R5
68K
IC2A
IC2C
IC2D
C2
27/33 pF
R11
18K
Q2
2N3904
Q3
2N4923
R12
1K
MATRIX TEST EQUIPMENT, INC.
200 WOOD AVENUE
MIDDLESEX, NEW JERSEY 08846
Title
AR-12 RECIEVER CONTROLLER
Size
A
Document Number
REV
Date: May 19, 1992
Sheet 1 of 4

FIGURE 1-10

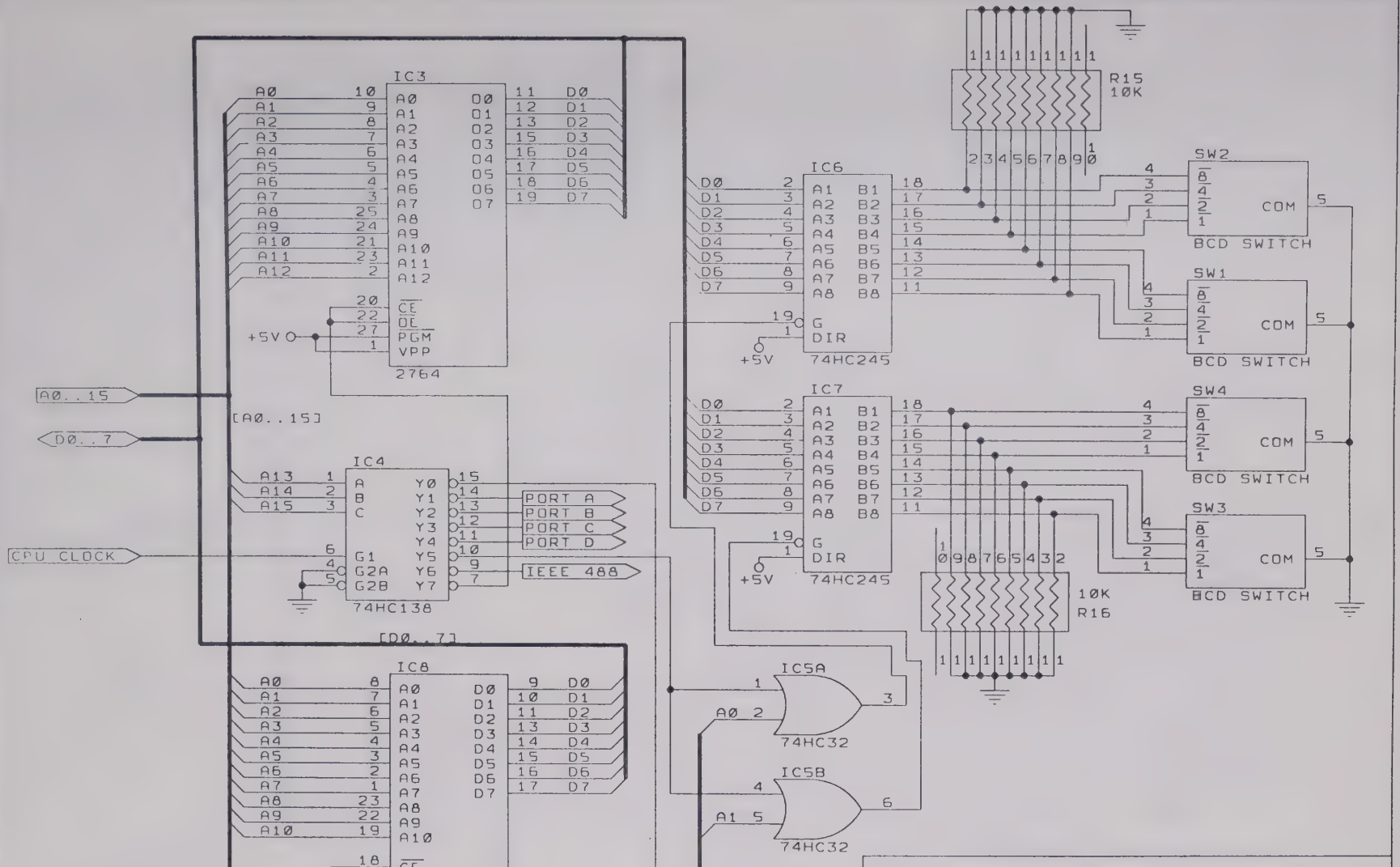



FIGURE 1-10

MATRIX TEST EQUIPMENT, INC.
200 WOOD AVENUE
MIDDLESEX, NEW JERSEY 08846

Title
AR-12 RECEIVER CONTROLLER

| Size | Document Number | REV |
|---|---|---|
| A | | 1 |

Date: May 27, 1992 Sheet 2 of 4

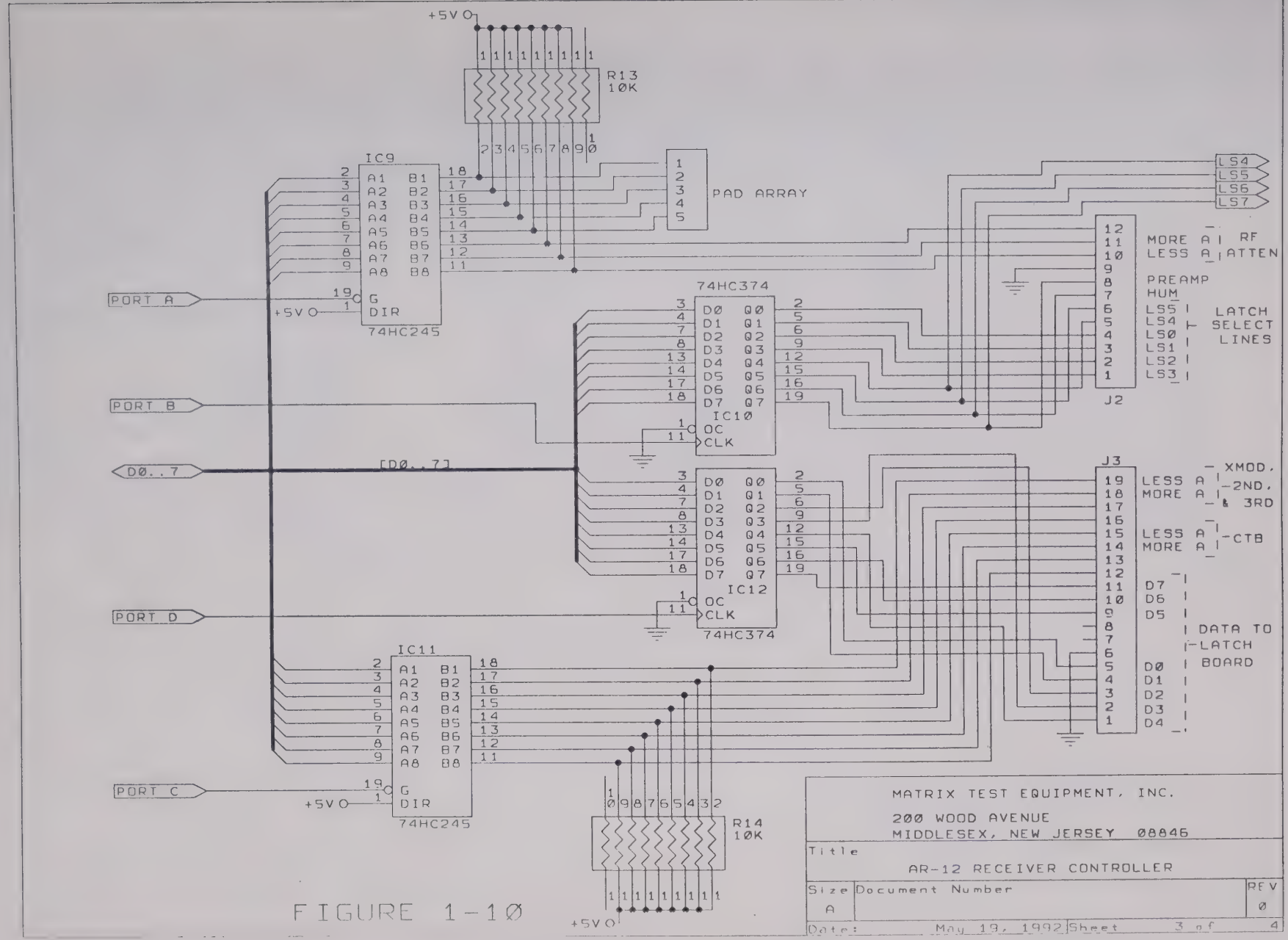



FIGURE 1-10

MATRIX TEST EQUIPMENT, INC.
200 WOOD AVENUE
MIDDLESEX, NEW JERSEY 08846

Title: AR-12 RECEIVER CONTROLLER

Size: A | Document Number | REV: 0

Date: May 19, 1992 | Sheet 3 of 4

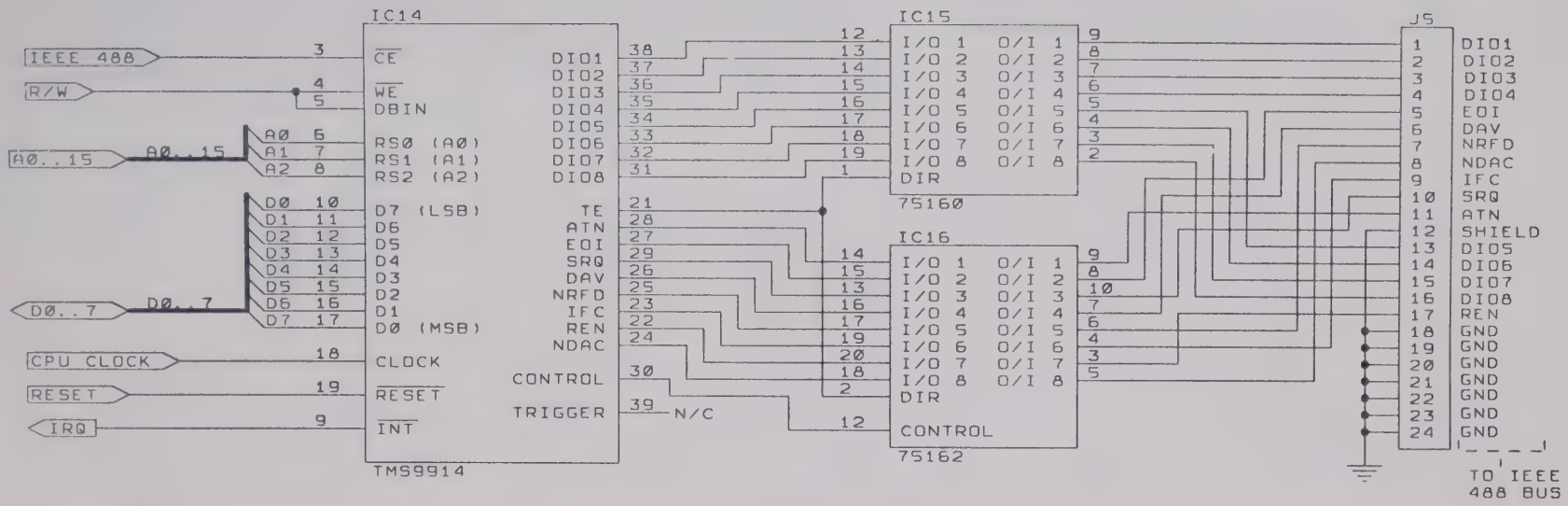



FIGURE 1-10

| | | |
|---|---|---|
| MATRIX TEST EQUIPMENT, INC.<br>200 WOOD AVENUE<br>MIDDLESEX, NEW JERSEY 08846 | | |
| Title: AR-12 RECEIVER CONTROLLER | | |
| Size: A | Document Number | REV: Ø |
| Date: May 19, 1992 | Sheet 4 of 4 | |

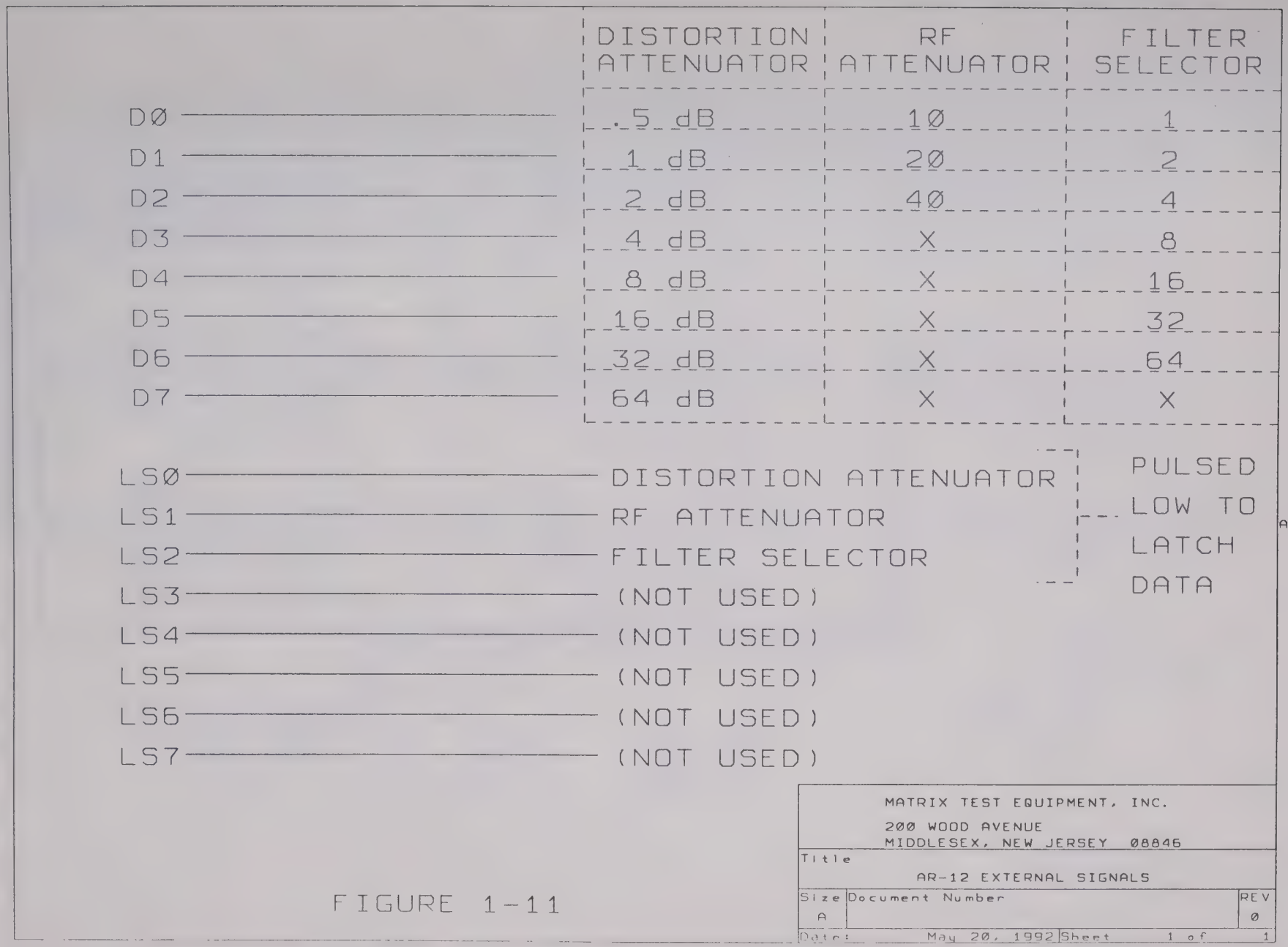

DISTORTION ATTENUATOR
RF ATTENUATOR
FILTER SELECTOR
D0
D1
D2
D3
D4
D5
D6
D7
.5 dB
1 dB
2 dB
4 dB
8 dB
16 dB
32 dB
64 dB
10
20
40
X
X
X
X
X
1
2
4
8
16
32
64
X
LS0 DISTORTION ATTENUATOR
LS1 RF ATTENUATOR
LS2 FILTER SELECTOR
LS3 (NOT USED)
LS4 (NOT USED)
LS5 (NOT USED)
LS6 (NOT USED)
LS7 (NOT USED)
PULSED LOW TO LATCH DATA
A1
MATRIX TEST EQUIPMENT, INC.
200 WOOD AVENUE
MIDDLESEX, NEW JERSEY 08846
Title
AR-12 EXTERNAL SIGNALS
Size A
Document Number
REV 0
Date: May 20, 1992
Sheet 1 of 1

FIGURE 1-11

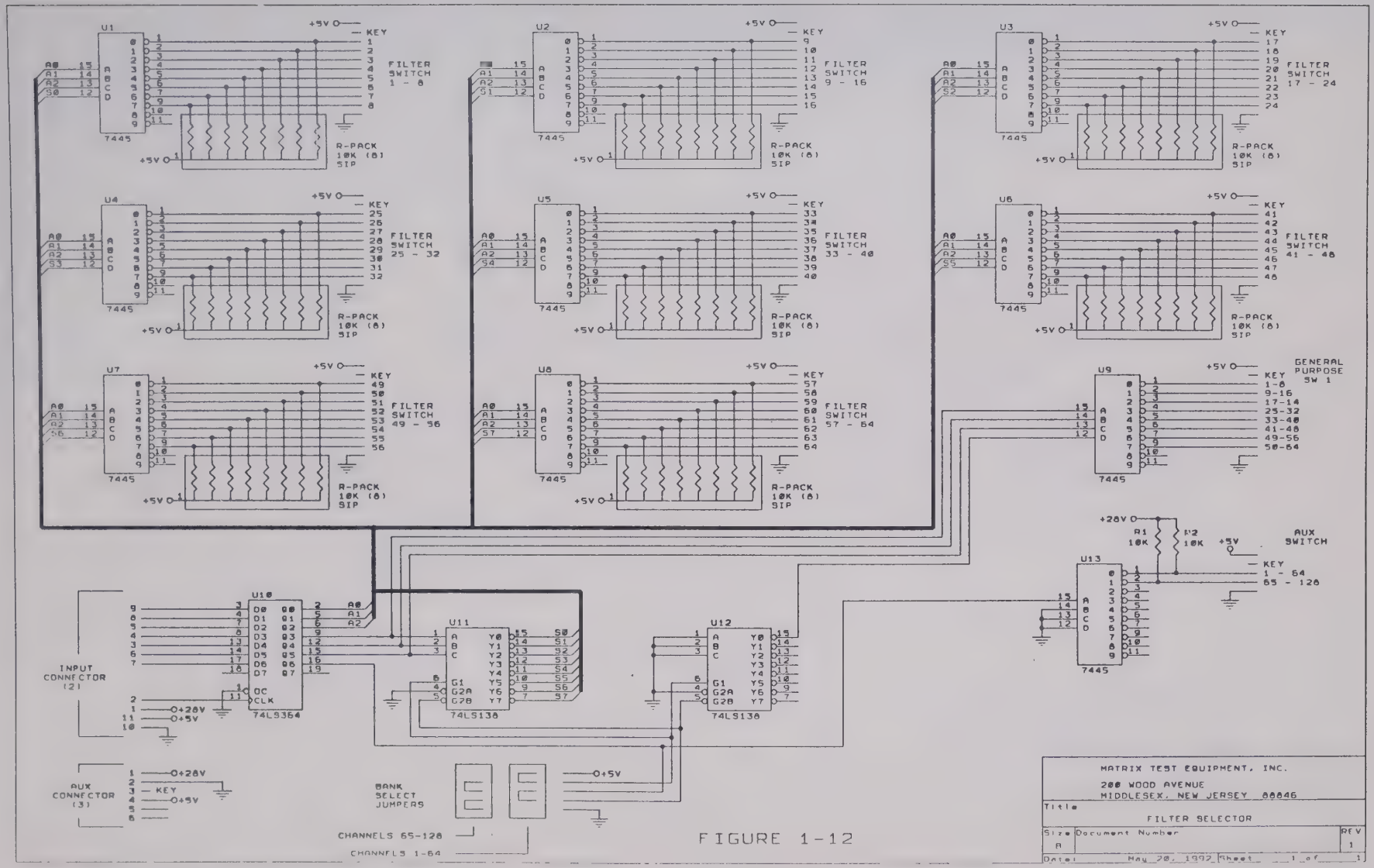

U1
U2
U3
U4
U5
U6
U7
U8
U9
U10
U11
U12
U13
7445
74LS138
74LS364
+5V
+28V
KEY
FILTER SWITCH 1 - 8
FILTER SWITCH 9 - 16
FILTER SWITCH 17 - 24
FILTER SWITCH 25 - 32
FILTER SWITCH 33 - 40
FILTER SWITCH 41 - 48
FILTER SWITCH 49 - 56
FILTER SWITCH 57 - 64
R-PACK 10K (8) SIP
GENERAL PURPOSE SW 1
AUX SWITCH
R1 10K
R2 10K
INPUT CONNECTOR (2)
AUX CONNECTOR (3)
BANK SELECT JUMPERS
CHANNELS 65-128
CHANNELS 1-64
MATRIX TEST EQUIPMENT, INC.
200 WOOD AVENUE
MIDDLESEX, NEW JERSEY 08846
Title
FILTER SELECTOR
Size A
Document Number
REV 1
Date: May 20, 1992 Sheet 1 of 1

FIGURE 1-12

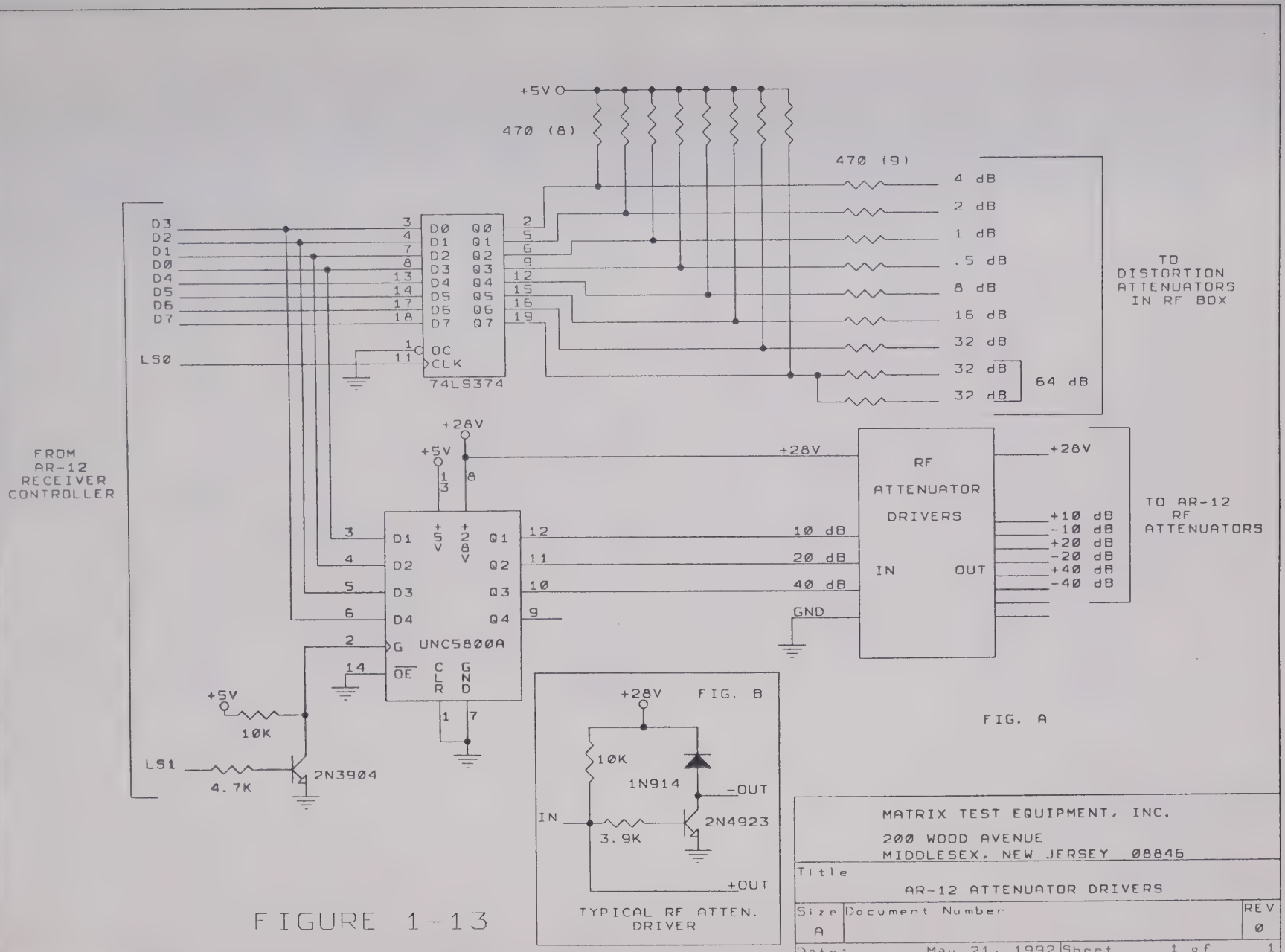



FIG. A

FIGURE 1-13

MATRIX TEST EQUIPMENT, INC.
200 WOOD AVENUE
MIDDLESEX, NEW JERSEY 08846

Title: AR-12 ATTENUATOR DRIVERS

Size: A | Document Number | REV: 0

Date: May 21, 1992 | Sheet 1 of 1

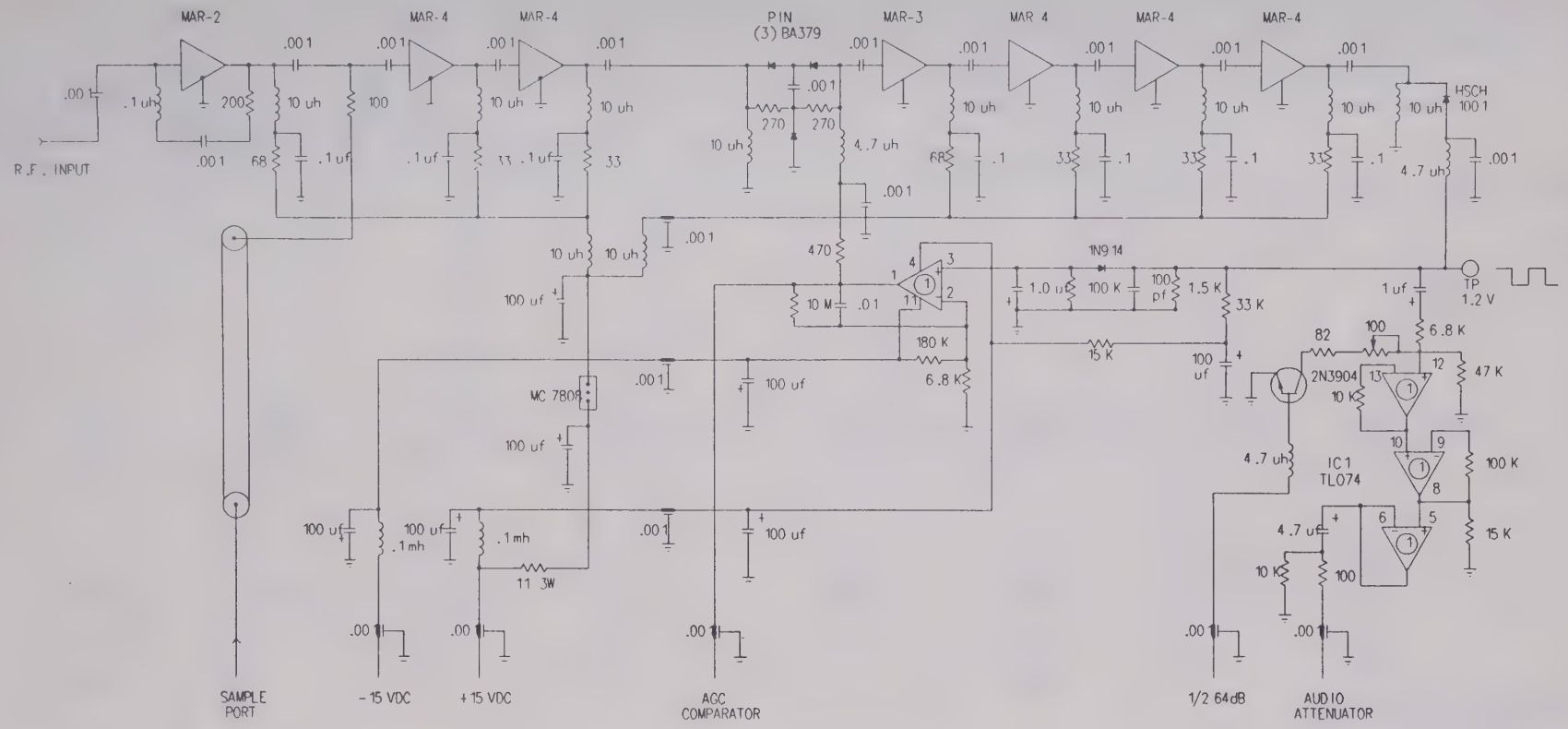



FIGURE 1 - 14A

| | | |
|---|---|---|
| MATRIX TEST EQUIPMENT INC. | | |
| MODEL AR-12 1000 Mhz RECEIVER RF BOX | | |
| REV. 2 WCAD 5/92 | DR. GLH DATE 5-10-90 CK. | DWG. NO. 1GCRFB |

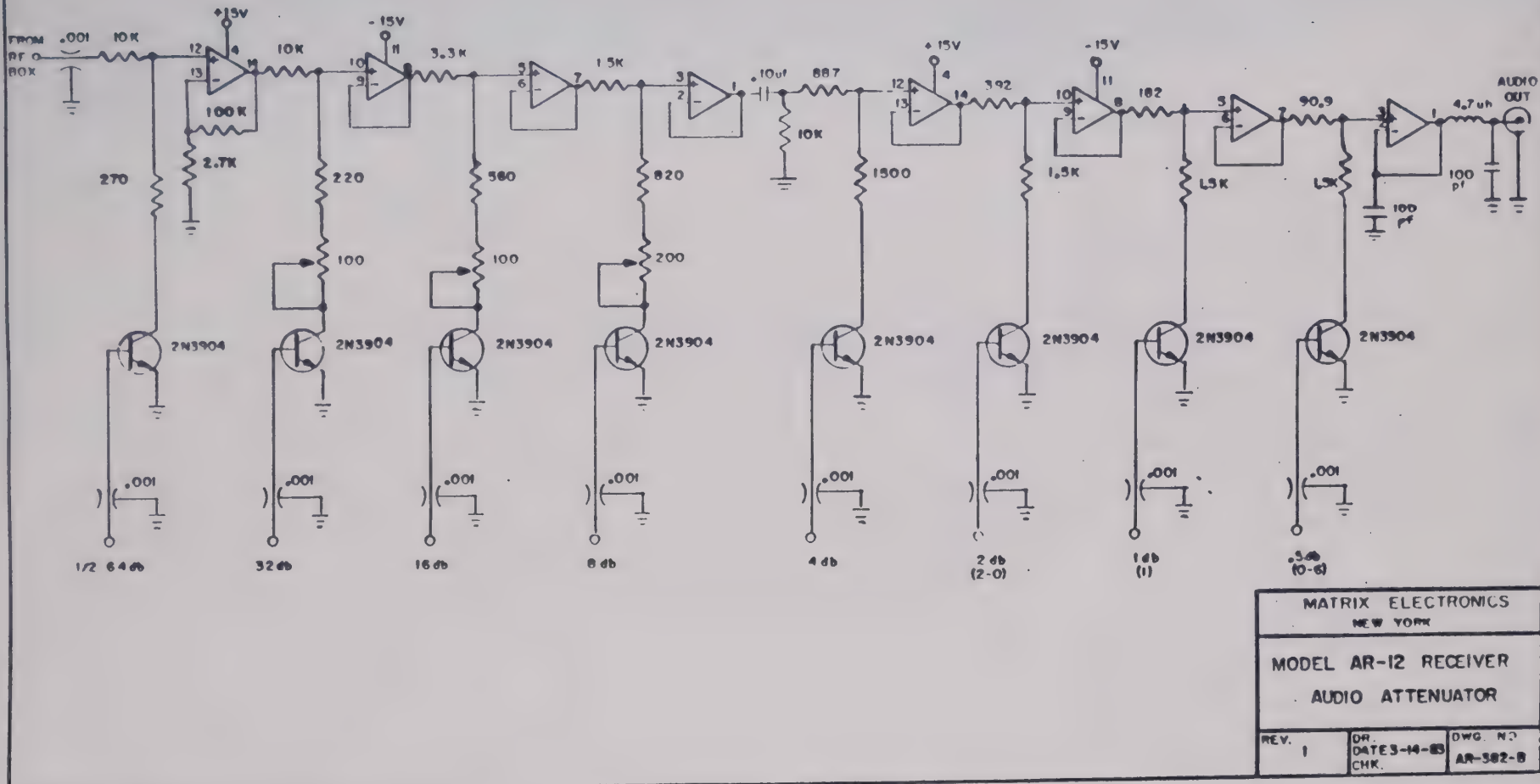

FROM RF BOX
.001
10K
+15V
-15V
100K
2.7K
270
220
100
2N3904
.001
1/2 64 db
32 db
3.3K
560
16 db
1.5K
820
200
8 db
.10uf
887
10K
1500
4 db
392
1.5K
2 db (2-0)
182
1.5K
1 db (1)
90.9
1.5K
.5db (0-6)
4.7uh
AUDIO OUT
100 pf
MATRIX ELECTRONICS
NEW YORK
MODEL AR-12 RECEIVER
AUDIO ATTENUATOR
REV. 1
DR.
DATE 3-14-85
CHK.
DWG. NO
AR-382-B

FIGURE 1-14B

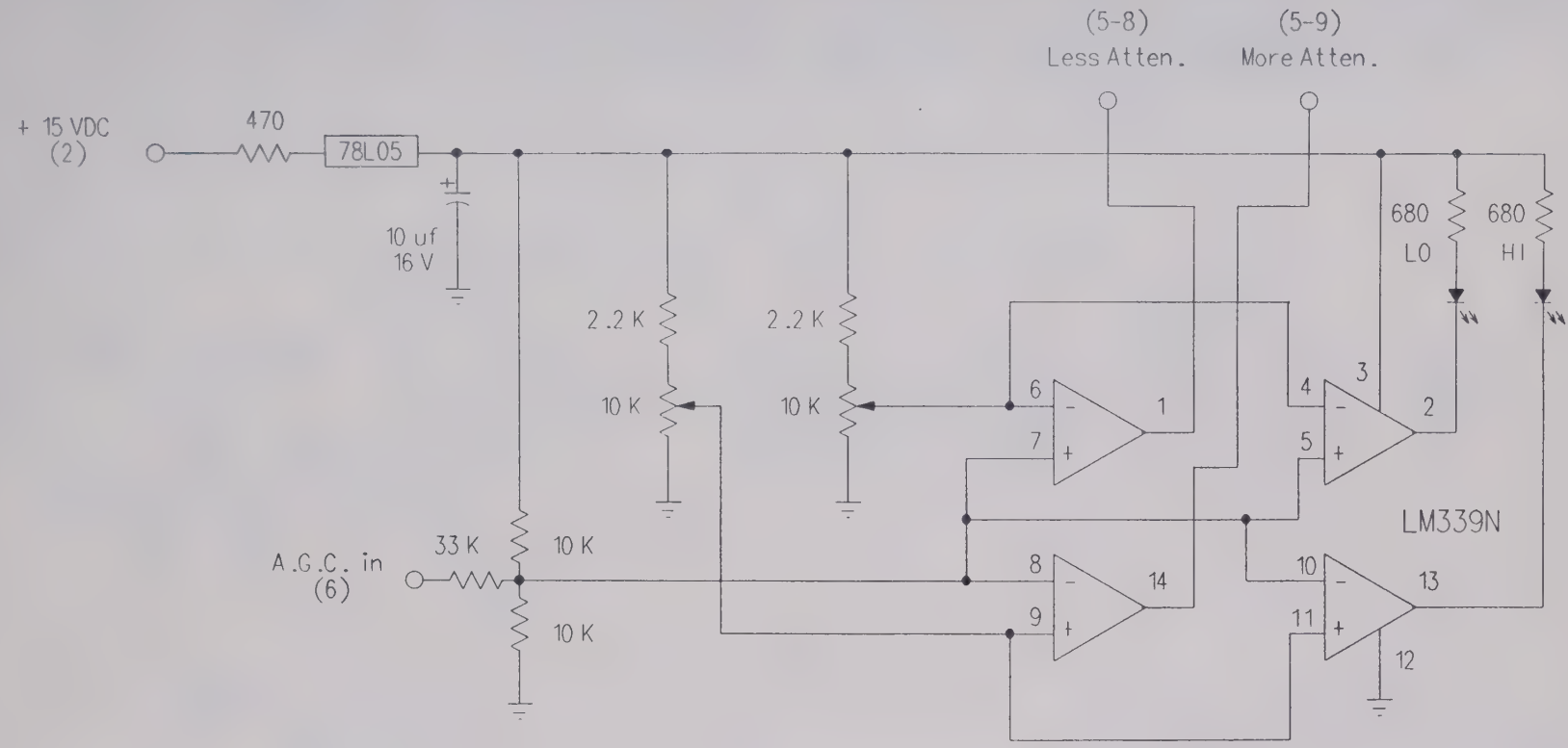
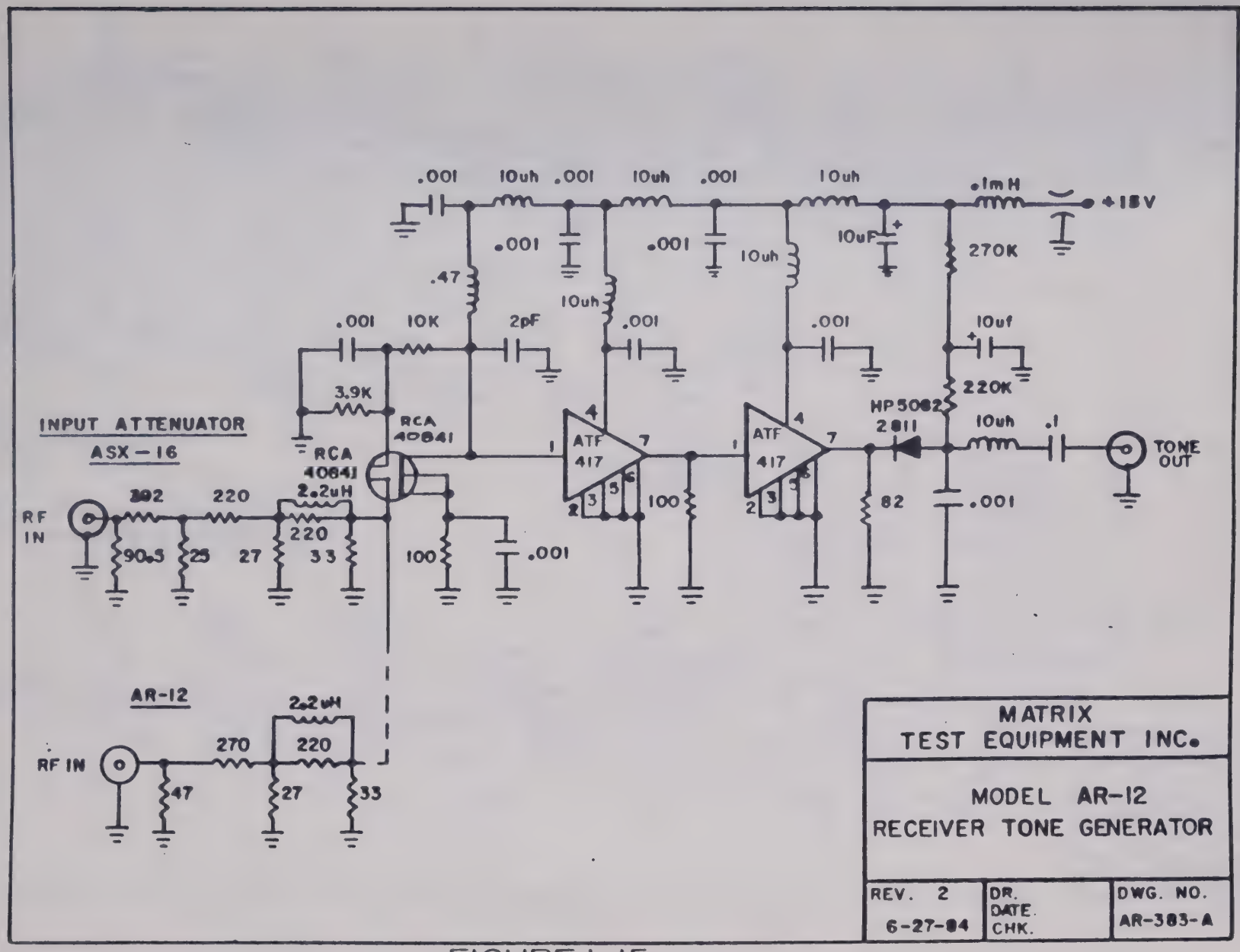

(5-8)
Less Atten.
(5-9)
More Atten.
+ 15 VDC
(2)
470
78L05
10 uf
16 V
2.2 K
10 K
2.2 K
10 K
680
LO
680
HI
LM339N
A.G.C. in
(6)
33 K
10 K
10 K
1
2
3
4
5
6
7
8
9
10
11
12
13
14

FIGURE 1-14C




MATRIX
TEST EQUIPMENT INC.

MODEL AR-12
RECEIVER TONE GENERATOR

| REV. 2 | DR. | DWG. NO. |
|---|---|---|
| 6-27-84 | DATE. | AR-383-A |
| | CHK. | |

FIGURE I-15

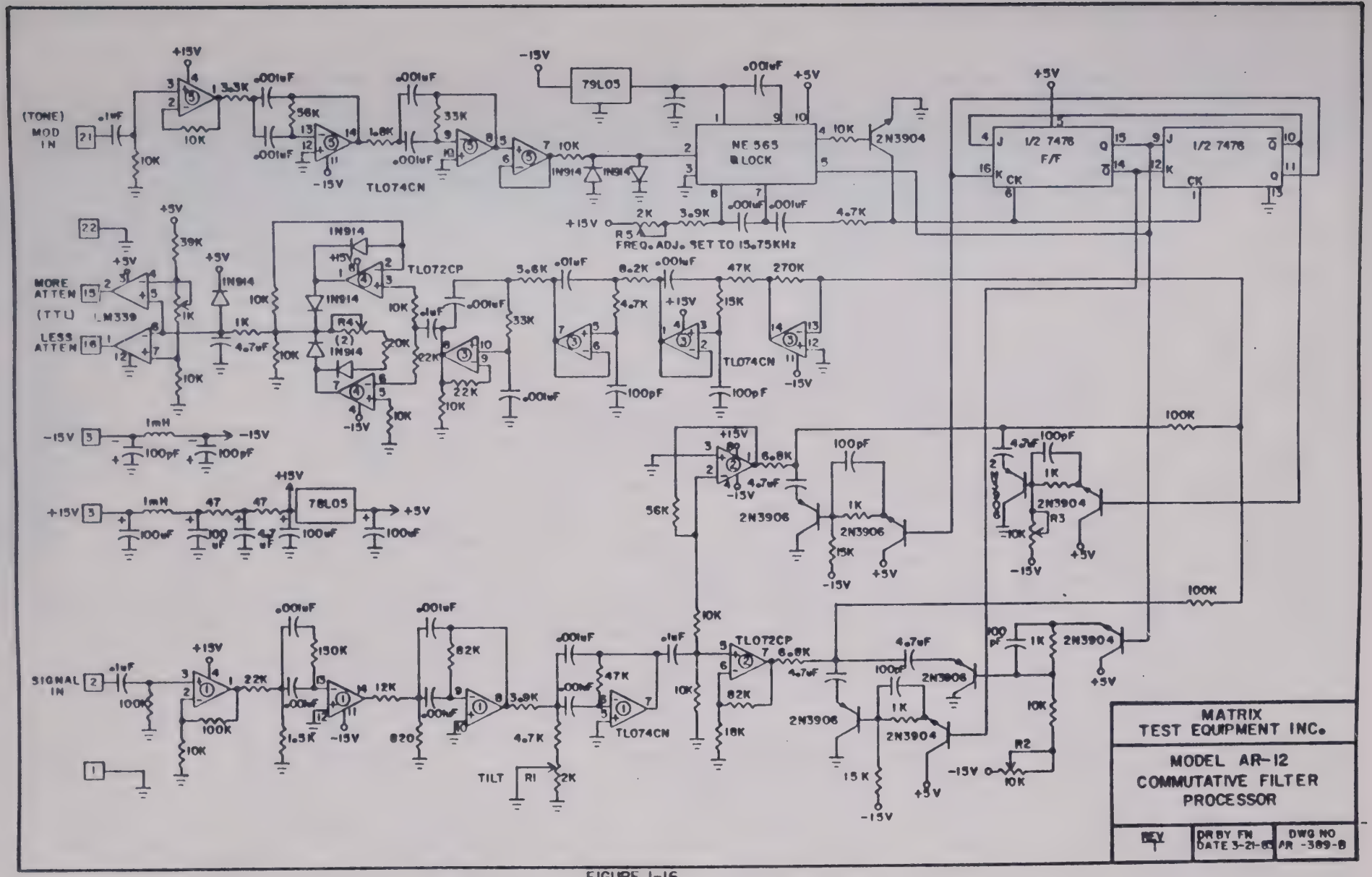

(TONE) MOD IN
SIGNAL IN
MORE ATTEN (TTL)
LESS ATTEN
LM339
TL074CN
TL072CP
79L05
NE 565 PLL LOCK
1/2 7476 F/F
2N3904
2N3906
IN914
FREQ. ADJ. SET TO 15.75KHz
TILT
MATRIX TEST EQUIPMENT INC.
MODEL AR-12 COMMUTATIVE FILTER PROCESSOR
DR BY FN
DATE 3-21-85
DWG NO AR-389-B
REV

FIGURE 1-16

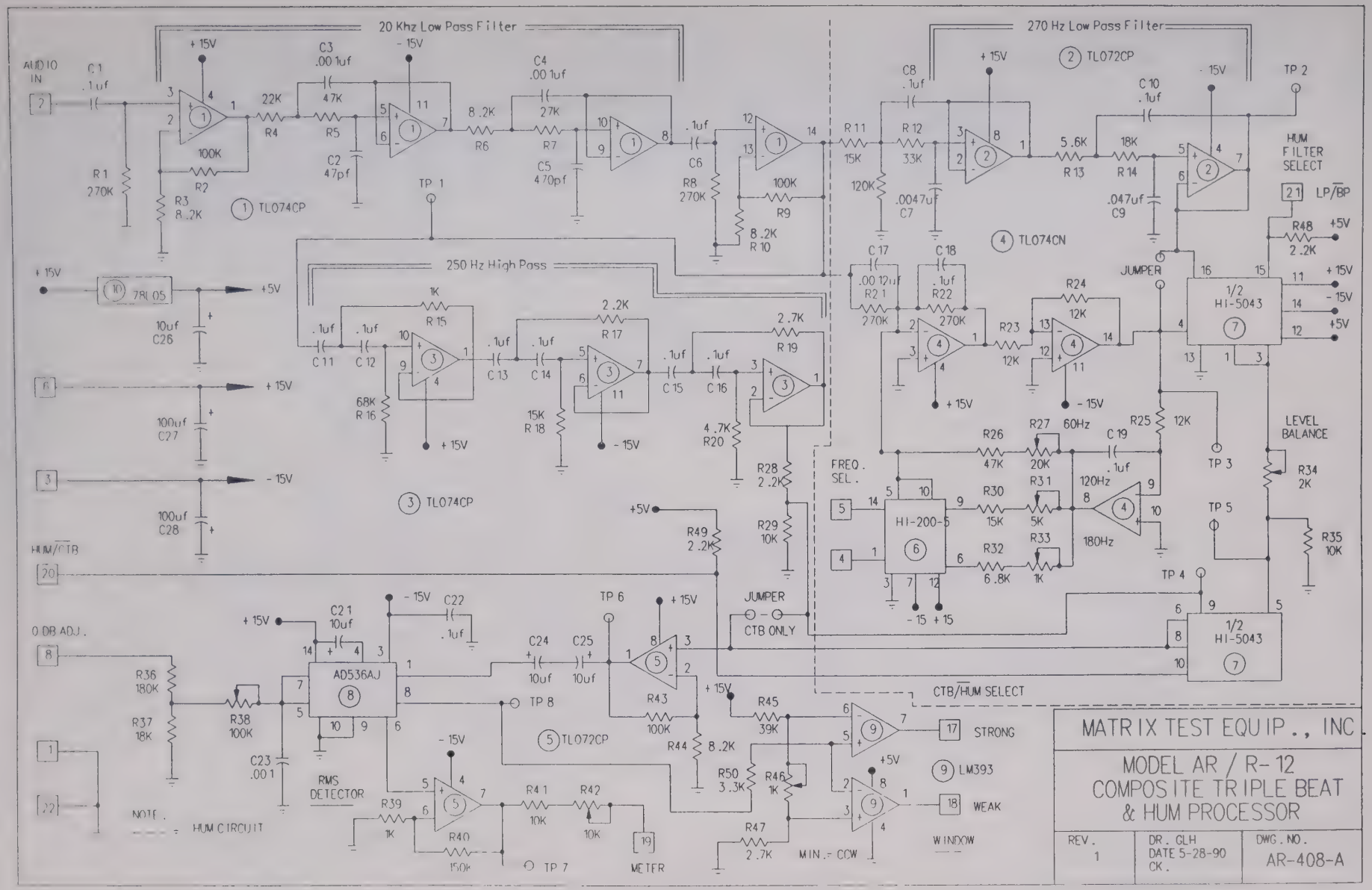
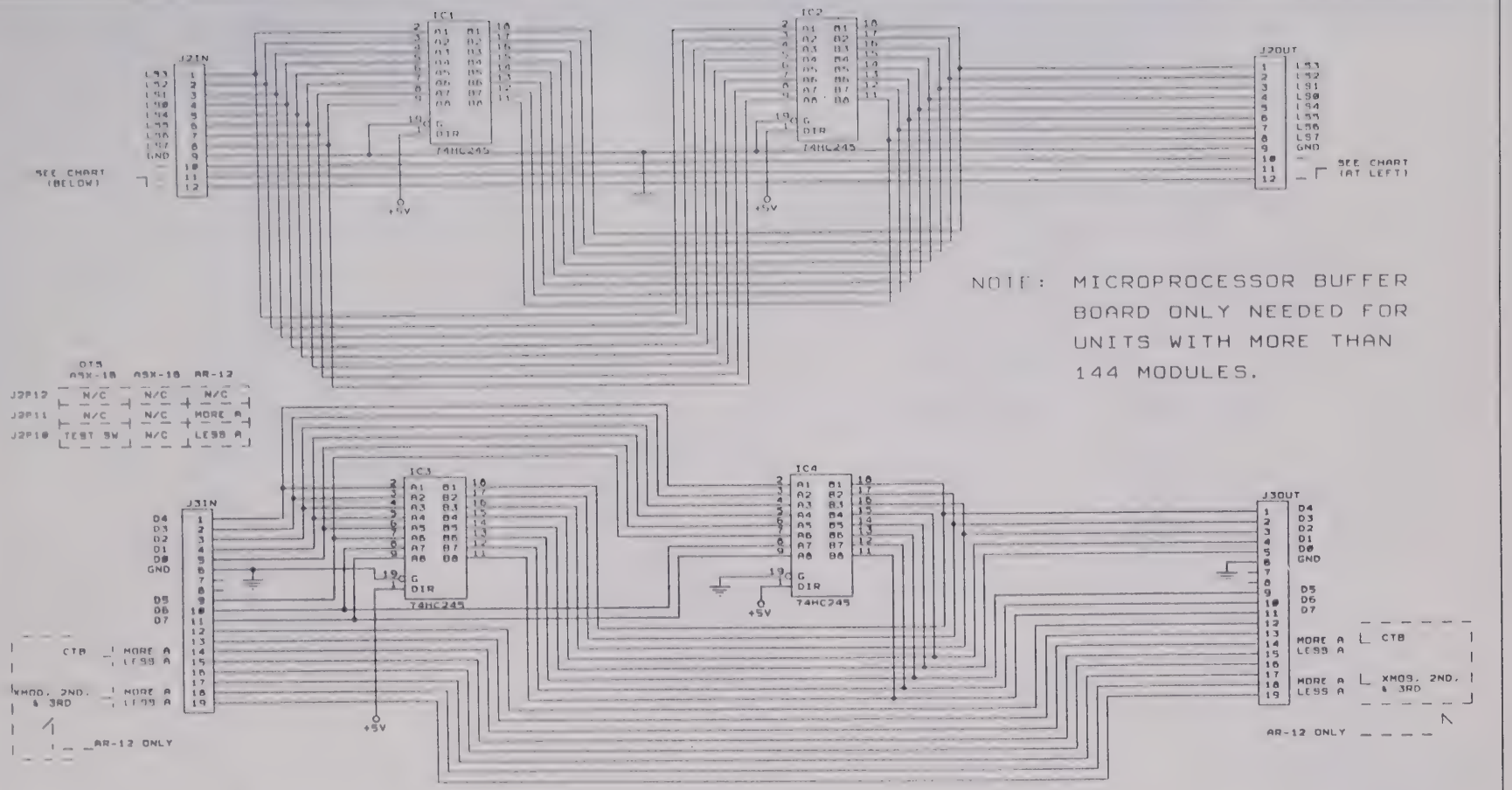

20 Khz Low Pass Filter
270 Hz Low Pass Filter
250 Hz High Pass
AUDIO IN
+ 15V
- 15V
+5V
TL074CP
TL072CP
TL074CN
78L05
AD536AJ
HI-200-5
1/2 HI-5043
HUM/CTB
0 DB ADJ.
RMS DETECTOR
JUMPER
CTB ONLY
CTB/HUM SELECT
HUM FILTER SELECT
LP/BP
FREQ. SEL.
LEVEL BALANCE
120Hz
180Hz
60Hz
TP 1
TP 2
TP 3
TP 4
TP 5
TP 6
TP 7
TP 8
METER
STRONG
LM393
WEAK
WINDOW
MIN. = CCW
NOTE: ---- = HUM CIRCUIT
MATRIX TEST EQUIP., INC
MODEL AR / R-12
COMPOSITE TRIPLE BEAT
& HUM PROCESSOR
REV. 1
DR. GLH
DATE 5-28-90
CK.
DWG. NO.
AR-408-A

FIGURE 1 - 17




NOTE: MICROPROCESSOR BUFFER BOARD ONLY NEEDED FOR UNITS WITH MORE THAN 144 MODULES.

FIGURE 1-18

MATRIX TEST EQUIPMENT, INC.
200 WOOD AVENUE
MIDDLESEX, NEW JERSEY 08846

Title: MICROCONTROLLER BUFFER

Size: A | Document Number | REV: 1

Date: May 21, 1992 | Sheet 1 of 1

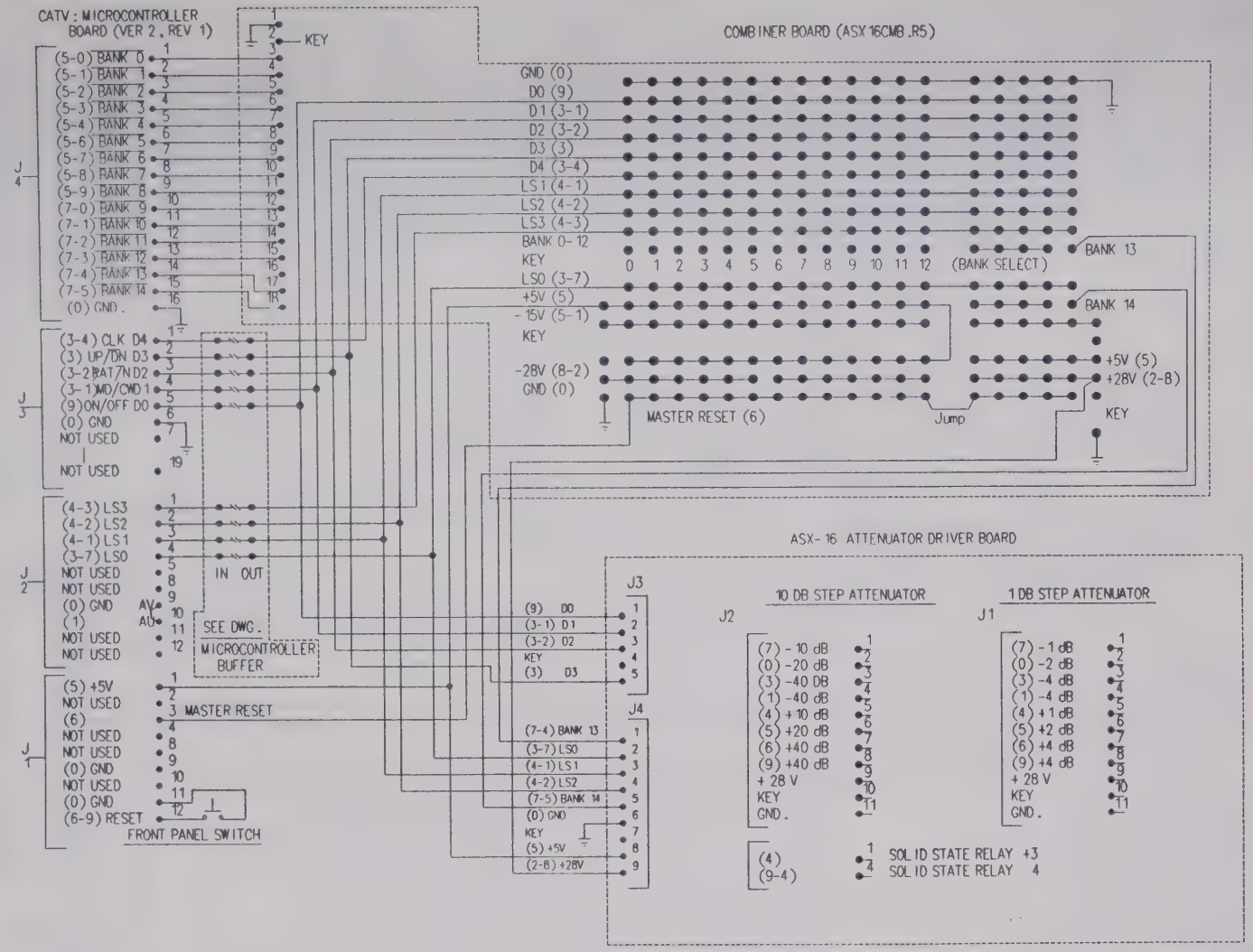
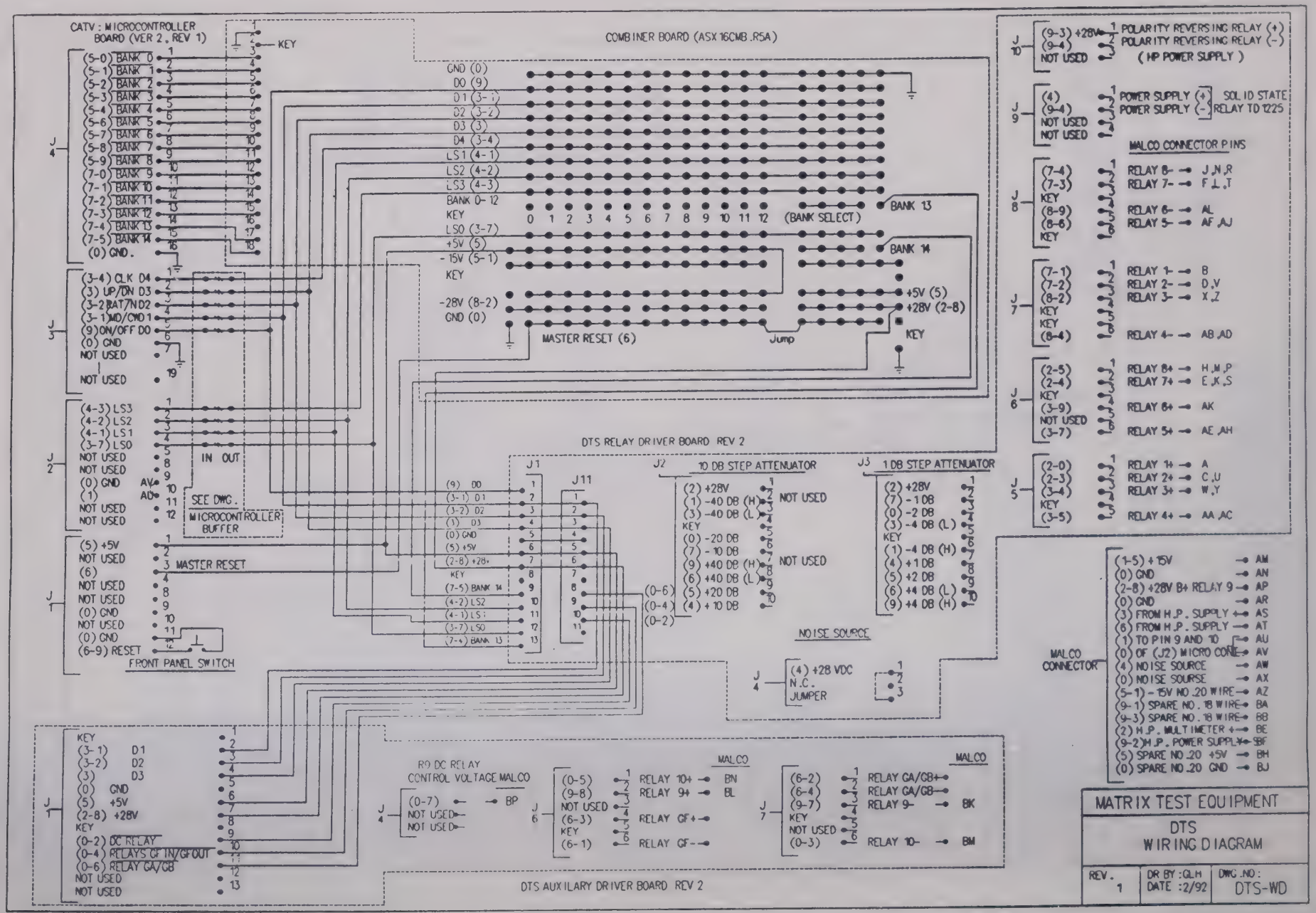



FIGURE 1-20

| MATRIX TEST EQUIPMENT | | |
|---|---|---|
| ASX-16 WIRING DIAGRAM | | |
| REV. 0 | DR BY : GLH DATE : 5/92 | DWG.NO : ASX-WD |


CATV : MICROCONTROLLER BOARD (VER 2 . REV 1)
COMBINER BOARD (ASX 16CMB .R5A)
DTS RELAY DRIVER BOARD REV 2
10 DB STEP ATTENUATOR
1 DB STEP ATTENUATOR
NOISE SOURCE
FRONT PANEL SWITCH
MICROCONTROLLER BUFFER
SEE DWG.
MASTER RESET
MASTER RESET (6)
Jump
(BANK SELECT)
BANK 13
BANK 14
KEY
POLARITY REVERSING RELAY (+)
POLARITY REVERSING RELAY (-)
( HP POWER SUPPLY )
POWER SUPPLY (+)
POWER SUPPLY (-)
SOLID STATE RELAY TD 1225
MALCO CONNECTOR PINS
MALCO CONNECTOR
R9 DC RELAY CONTROL VOLTAGE MALCO
DTS AUXILARY DRIVER BOARD REV 2
MATRIX TEST EQUIPMENT
DTS
WIRING DIAGRAM
REV . 1
DR BY : GLM
DATE : 2/92
DWG .NO : DTS-WD

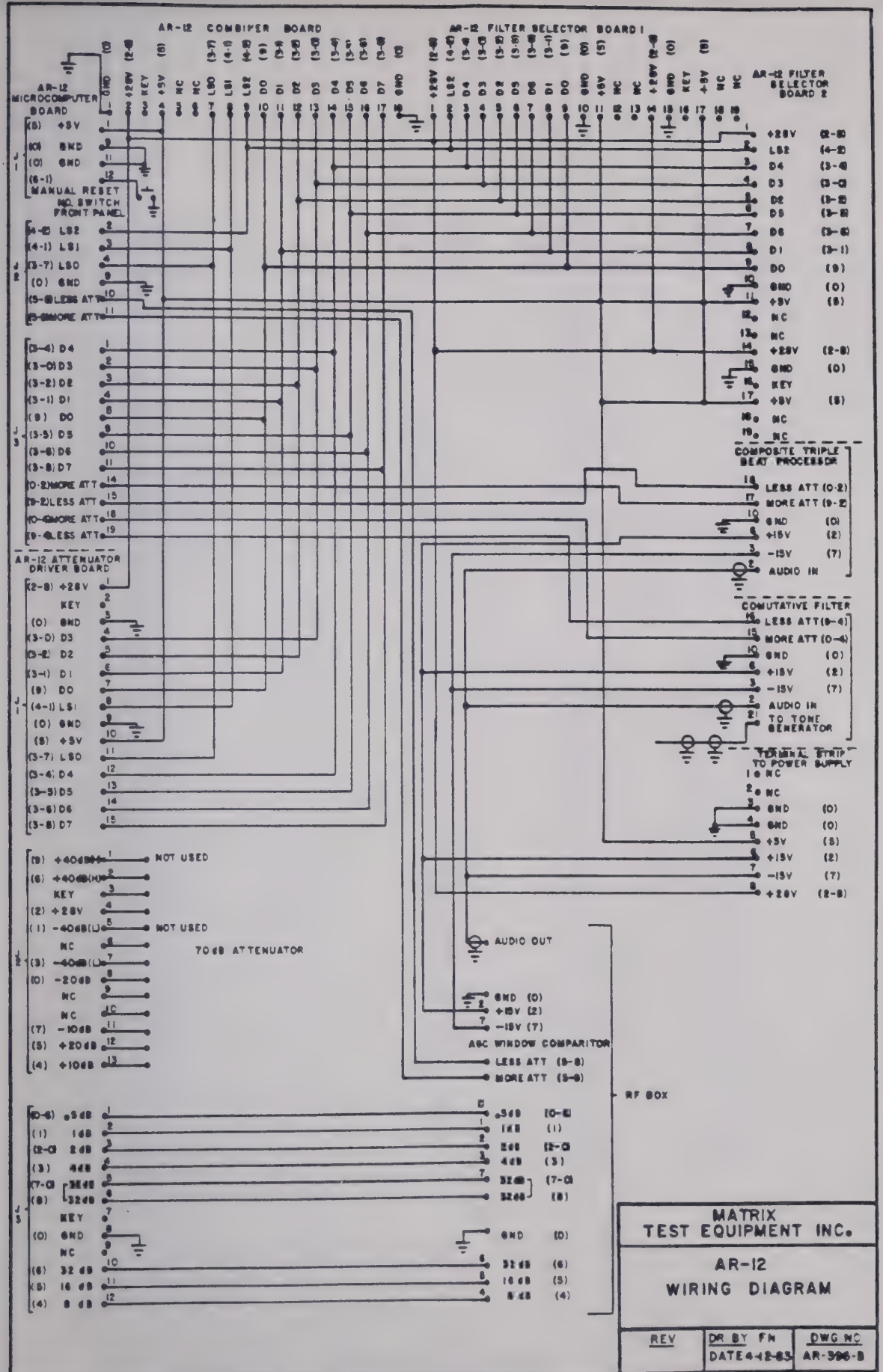

AR-12 COMBINER BOARD
AR-12 FILTER SELECTOR BOARD 1
AR-12 FILTER SELECTOR BOARD 2
AR-12 MICROCOMPUTER BOARD
MANUAL RESET NO. SWITCH FRONT PANEL
COMPOSITE TRIPLE BEAT PROCESSOR
COMUTATIVE FILTER
TO TONE GENERATOR
TERMINAL STRIP TO POWER SUPPLY
AR-12 ATTENUATOR DRIVER BOARD
NOT USED
70 dB ATTENUATOR
AUDIO OUT
AGC WINDOW COMPARITOR
RF BOX
MATRIX TEST EQUIPMENT INC.
AR-12 WIRING DIAGRAM
REV
DR BY FN
DATE 4-12-83
DWG NO AR-396-B

FIGURE 1-21

**Table 2.1** Relationship of Module Number to Channel Number for Model ASX-16 Serial No. **152 A-1**

| Module Access Number | Channel Designation | Channel Frequency | Module Access Number | Channel Designation | Channel Frequency |
|---|---|---|---|---|---|
| 1 | CH.2 | 55.25 | 44 | M-4 | 337.25 |
| 2 | CH.3 | 61.25 | 45 | M-5 | 343.25 |
| 3 | CH.4 | 67.25 | 46 | M-6 | 349.25 |
| 4 | CH.5 | 77.25 | 47 | M-7 | 355.25 |
| 5 | CH.6 | 83.25 | 48 | M-8 | 361.25 |
| 6 | A-2 | 109.25 | 49 | M-9 | 367.25 |
| 7 | A-1 | 115.25 | 50 | M-10 | 373.25 |
| 8 | CH.A | 121.25 | 51 | M-11 | 379.25 |
| 9 | CH.B | 127.25 | 52 | M-12 | 385.25 |
| 10 | CH.C | 133.25 | 53 | M-13 | 391.25 |
| 11 | CH.D | 139.25 | 54 | M-14 | 397.25 |
| 12 | CH.E | 145.25 | 55 | M-15 | 403.25 |
| 13 | CH.F | 151.25 | 56 | M-16 | 409.25 |
| 14 | CH.G | 157.25 | 57 | M-17 | 415.25 |
| 15 | CH.H | 163.25 | 58 | M-18 | 421.25 |
| 16 | CH.I | 169.25 | 59 | M-19 | 427.25 |
| 17 | CH.7 | 175.25 | 60 | M-20 | 433.24 |
| 18 | CH.8 | 181.25 | 61 | M-21 | 439.25 |
| 19 | CH.9 | 187.25 | 62 | M-22 | 445.25 |
| 20 | CH.10 | 193.25 | 63 | M-23 | 451.25 |
| 21 | CH.11 | 199.25 | 64 | M-24 | 457.25 |
| 22 | CH.12 | 205.25 | 65 | M-25 | 463.25 |
| 23 | CH.13 | 211.25 | 66 | M-26 | 469.25 |
| 24 | CH.J | 217.25 | 67 | M-27 | 475.25 |
| 25 | CH.K | 223.25 | 68 | M-28 | 481.25 |
| 26 | CH.L | 229.25 | 69 | M-29 | 487.25 |
| 27 | CH.M | 235.25 | 70 | M-30 | 493.25 |
| 28 | CH.N | 241.25 | 71 | M-31 | 499.25 |
| 29 | CH.O | 247.25 | 72 | M-32 | 505.25 |
| 30 | CH.P | 253.25 | 73 | M-33 | 511.25 |
| 31 | CH.Q | 259.25 | 74 | M-34 | 517.25 |
| 32 | CH.R | 265.25 | 75 | M-35 | 523.25 |
| 33 | CH.S | 271.25 | 76 | M-36 | 529.25 |
| 34 | CH.T | 277.25 | 77 | M-37 | 535.25 |
| 35 | CH.U | 283.25 | 78 | M-38 | 541.25 |
| 36 | CH.V | 289.25 | 79 | M-39 | 547.25 |
| 37 | CH.W | 295.25 | 80 | M-40 | 553.25 |
| 38 | CH.X | 301.25 | 81 | M-41 | 559.25 |
| 39 | CH.Y | 307.25 | 82 | M-42 | 565.25 |
| 40 | CH.Z | 313.25 | | | |
| 41 | M-1 | 319.25 | | | |
| 42 | M-2 | 325.25 | | | |
| 43 | M-3 | 331.25 | | | |

26 = 235.25
M = 235.25

MP MASTER
MA29165